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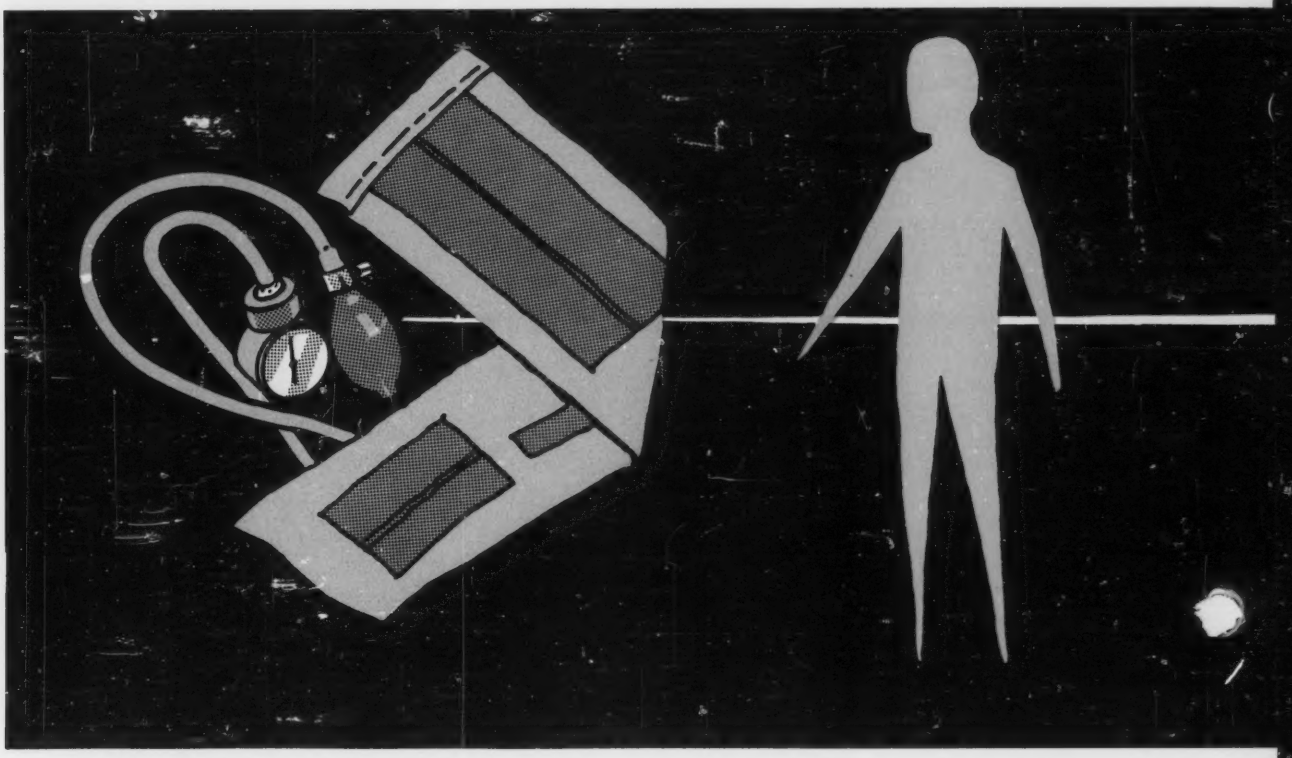

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J. B. LIPPINCOTT COMPANY
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Application to mail at controlled circulation rates pending at East Stroudsburg, Pa. Published bi-monthly by J. B. Lippincott Company, East Washington Square, Philadelphia, Pa. 19105. Subscription price $12.00 U.S. and Canada, all other countries $14.00. Special student rate U.S. only $10.00. Single copy price $3.00. Printed in U.S.A. Copyright © 1975. J. B. Lippincott Company.

THE JOURNAL OF
preventive dentistry
Vol. 2 • No. 1 January - February 1975

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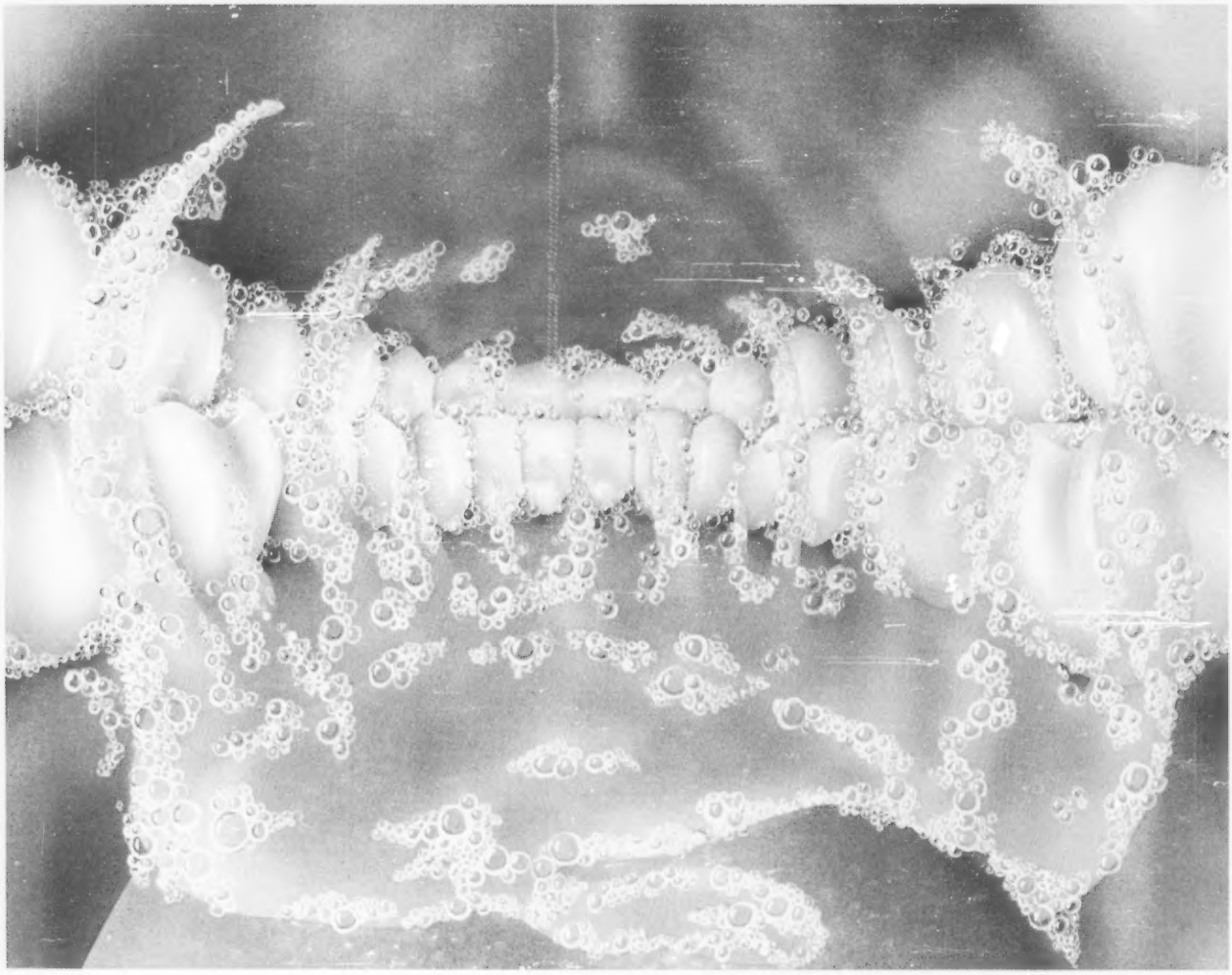

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27% caries reduction. A third study[3] was done in the United States by Aasenden, DePaola and Brudevold. It was a 3-year study among children 8-11 who rinsed daily in school during the school year only. A 5 ml. dose of a .05% neutral sodium fluoride solution was rinsed for one minute, then swallowed. The results showed a 27% DFS reduction.

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High Blood Pressure: *A Time for Action*

Charles L. Berman, D.D.S.*

Based on national statistics, 6 to 8 of your next 40 adult patients will have high blood pressure—yet only one of them is receiving adequate treatment. The others aren't aware that their blood pressure is elevated, don't take it seriously enough to continue with ongoing treatment, or are receiving inadequate care. In any case, your screening of their condition and referral to their physician will be the main factor that motivates them to seek and accept the care that will prolong their lives.

Uncontrolled high blood pressure is a "silent killer." It is a leading cause of heart attack and stroke, and is a major etiologic factor in 1000 deaths per day in the USA. It usually does not cause symptoms, it offers no warning, and its unknowing victims continue to go about their daily lives without realizing that anything is wrong until they are detected and treated or a major, and perhaps fatal, morbid event occurs.

Since many people see their physicians only when they feel sick, but visit their dentists regularly or are compelled to by symptoms, the dentist and his office staff have an excellent opportunity to detect high blood pressure in those who might otherwise remain unaware. For this reason, the National High Blood Pressure Education Program has called on all dentists to participate in this country's efforts to control HBP.

ORGANIZATION

A dentist who routinely measures the blood pressures of his patients can help identify a significant number of people with high blood pressure. When most or all of the dentists in a community participate, the benefits are multiplied, putting a substantial dent in the problem. To be widely successful, however, such an effort must be well planned and organized.

To achieve this goal it maybe helpful to work with an educational institution, a community department of health, a dental or medical society, a Red Cross Chapter, a heart association, or a regional hospital. A dentist can initiate a blood pressure screening program by approaching individuals from these groups as co-sponsor(s) of the project and form an inter-agency committee. The members of this committee should be chosen carefully. The

* Director of the High Blood Pressure Education and Detection Program at Fairleigh Dickinson University, School of Dentistry, Hackensack, N.J. 07601.

Reprinted from the New Jersey Dental Association, Fall, 1974.

success of the program depends on their enthusiasm and ability to work closely together in an attitude of mutual respect and cooperation.

The committee's first job is to establish an administrative office, and to identify goals and develop a strategy for meeting those goals. Undoubtedly, one of the co-sponsors can act as administrator. The next primary goal would be to involve as many dentists in the program as possible. To accomplish this goal, the strategy will have to incorporate persistence and a good educational program. On an average, at least 10 to 15 per cent of the dentists in a community will immediately see the merits of a high blood pressure screening program and will be willing to participate. The remaining 85 to 90 per cent must be educated about the importance of the project and motivated. It is not unreasonable to expect as many as 50 per cent of all local dentists to join a well organized program in the first year.

EDUCATION

Various pamphlets, articles and films on high blood pressure screening are useful in motivating dentists to accept the program. These can be obtained from Fairleigh Dickinson University School of Dentistry, Department of Continuing Education, 110 Fuller Place, Hackensack, New Jersey 07601, and the National High Blood Pressure Information Center at 7910 Woodmont Avenue, Suite 1012, Bethesda, Maryland, 20014. This information should be used to supplement local data. An excellent way to collect this data is to initiate the program with a small group of dentists who are enthusiastic about the idea. These dentists can then report their own findings regarding procedures, benefits to the dentist and his practice, patient reaction, incidence of high blood pressure, methods of referral and counseling of patients who have discontinued treatment.

In addition to helping the high blood pressure screening program get started, educational programs can be a means of sustaining interest. Continuing education on the local level can be tied in with other dental education programs in the area, or can be set up independently. Training sessions can be used to present information from current studies on high blood pressure, to teach dentists and auxiliary personnel the procedures of blood pressure evaluation, and to discuss related topics, such as medical and dental management of the hypertensive patient.

PUBLICITY

Articles in professional journals and the local press will generate an initial awareness and develop enthusiasm for the program, increase public acceptance and appreciation of the idea, and explain it to local physicians so they will not be caught unaware when the referrals begin.

Initial news releases can announce the program and explain its purpose. Later, news about the results of the program can be presented. Reporters might be invited to training sessions and other activities so that they get a first-hand view of the program. This can lead to ongoing news and feature coverage. For example, demonstrations of the use of a "double stethescope technique" whereby two stethescopes are joined with a "y" tube, and only one diaphram is used. The teacher wears one set, and the student the other.

REFERRAL

If the effort to detect high blood pressure is to bring about positive action, special attention should be given to the method of referral. *The cardinal rule of referral is always speak with the physician first.* The decision of whether he should see the patient is up to him. To simply tell the patient that he should see his medical doctor because his blood pressure is elevated is not enough. This procedure might not motivate the patient to see his physician. Still worse, it might have negative repercussions.

For example, the blood pressure elevation at the time that the patient went to the dentist might be merely a momentary stress increase that is no longer present when he is examined by his physician. The physician may become annoyed that the referral was made without consulting him and may offer a few uncomplimentary remarks about the dentist as he tells the patient that his blood pressure is normal. This problem can be very discouraging to the dentist and patient and can undermine the entire program.

Avoiding this problem is quite simple: talk with the physician, tell him what your blood pressure reading was, and ask his

advice. This way, the physician can decide whether the patient requires further evaluation. The physician is much more likely to respect you as one who is concerned with his patients' total welfare. *Of course*, the patient's consent should be obtained before the physician is consulted.

TREATMENT DROP-OUTS

Because of lack of understanding about the dangers of high blood pressure, because of resistance to taking medication when no symptoms are present, or because of problems encountered during treatment, many patients with high blood pressure abandon their treatment programs. It is not uncommon, therefore, for the dentist to detect high blood pressure and be told that the patient is aware of his condition and was previously under treatment. When this occurs, the dentist should ask the patient why he discontinued treatment, should attempt to resolve any misunderstandings, and should ask the patient's permission to call his physician for advice. It is natural that from time to time patients have interpersonal relationship problems with their physicians. Should the patient not wish to be treated by a particular physician it is most appropriate for you to arrange for them to see another physician.

CONCLUSIONS

Dentists and their staff can render a unique health and education service to their patients and their families by measuring the blood pressure of all patients, including children, as a standard office procedure. If the physician is called when making the referral, over 90 per cent of patients in whom high blood pressure is suspected can be expected to follow through by seeing their physicians. Thus, *a high blood pressure screening program* conducted by dentists can help significantly in reducing the high incidence of premature death and disability from high blood pressure. The time for action is now!

No Link Between Cereals and Tooth Decay

An extensive two-year study carried out at the Forsythe Dental Center has yielded important findings which end the controversy surrounding the relationship of regular and presweetened cereals to tooth decay in children.

According to the study, no increase in dental caries can be linked to children's consumption of ready-to-eat cereals. The Researchers conclude that the tooth decay produced by certain foods may not be highly correlated with their sucrose content alone. Other factors, such as the time they are eaten, the consistency of the food, and the conditions under which it is eaten, may be as important as the sucrose content in determining how it may contribute to tooth decay.

The study involved 979 children aged 7 to 11 years from eastern Massachusetts communities with little or no fluoride in their drinking water. After thorough dental examinations during a two-year span, only expected rates of tooth decay were found for the participants. There was no association between the amount of cereal consumed and tooth decay, or between cereal consumption and need for dental treatment. Furthermore, the pattern of tooth decay was similar to, although somewhat less then, that reported for all children from Massachusetts of the same age distribution.

Anomalies of the Teeth with Stains and Discolorations

Ellen Eisenberg, D.M.D.** and Sheldon M. Bernick, D.D.S.*

Fig. 1.

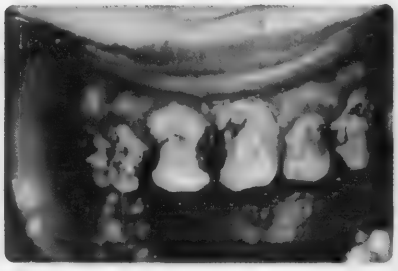

Fig. 2.

Fig. 3.

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Fig. 6.

Fig. 7.

Fig. 8.

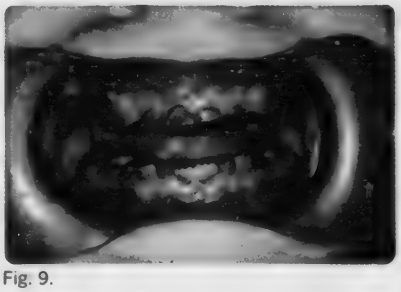

Fig. 9.

Fig. 10.

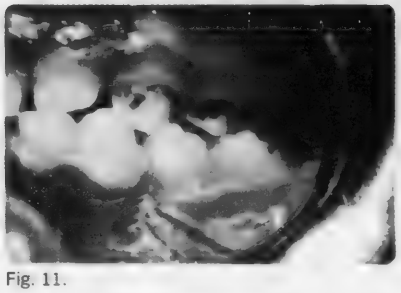

Fig. 11.

Fig. 12.

FIG. 1. Intrinsic stains. FIG. 2. Dirty mouth. FIG. 3. Discoloration caused by trauma. FIG. 4. Hypoplasia. FIG. 5. White opacity caused by Hypoplasia. FIG. 6. Yellow-orange stain. FIG. 7. Ricketts. FIG. 8. Tea bottle caries. FIG. 9. Dentinogenesis imperfecta. FIG. 10. Green stain. FIG. 11. P_6 stain. FIG. 12. Supernumerary and Turner's teeth.

Unless one is asked to provide a color match for a dental restoration, such as a denture or a fixed bridge, little thought or description (other than the standard descriptive "white" or "yellow") is given to the color of teeth. Actually, shade differences in tooth coloration are infinite, since the color of teeth is determined by enamel translucency which imparts various outward hues such as green, pink or blue superimposed on the yellow or brownish color of the deeper layers of dentine.

The causes of tooth discoloration are manifold and the origin of these changes may be endogenous or exogenous. Often, preeruption structural changes and thickness changes of the dental hard tissues (enamel and dentine, specifically) will leave the resulting tooth with an appearance which noticeably differs from the norm; penetration of the dentine or enamel (or both) by coloring agents after the formation of these hard tissues, in the presence or absence of structural changes, or the incorporation of coloring agents into the dental hard tissues during formation with accompanying structural changes will impart similar damage to the appearance and often, the function of the tooth during and after eruption.

Post-eruption discolorations occur when discoloring agents enter the dental hard tissues through the pulp or enamel organ or when an agent of discoloration penetrates the enamel or dentine from the oral cavity or is superficially associated with these structures *via* this route.

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Dr. Bernick is Assistant Professor of Pediatric Dentistry at the University of Pennsylvania, School of Dental Medicine, Philadelphia, Pa.

EXTRINSIC STAINING

When we speak of extrinsic staining, it would be wise to keep in mind that the oral cavity is endowed with a rather "well-integrated" flora of bacteria and mycotic organisms performing all of their functions in a relatively homeostatic neighborhood. They survive anywhere in the oral cavity, increase in numbers, and produce waste products which lead to changes in tooth crown color.

Nasmyth's membrane, a weak, delicate covering of the newly erupted tooth crown which originates in the ameloblasts that form the familiar enamel rods, is subject to rapid wear once the tooth has erupted into the oral cavity. The remnant of this membrane (or primary enamel cuticle, which is merely a thin, continuous layer covering the entire enamel surface) is vulnerable to staining by food debris and bacteria of a chromogenic nature. Cells, food particles, bacteria and mycotic organisms are in turn stained by food, tobacco, beverages and mouthwashes.

Calculus will result in a change in outward coloration of the teeth. Calculus accumulates more rapidly in certain individuals than in others and often is related to the surface roughness and irregularities of teeth not cleansed simply by mechanical chewing. Subgingival calculus is characteristically dark green, sometimes black, hard and flinty whereas the visible supragingival calculus is more whitish yellow in color and softer.

The mucinous content of saliva leaves viscous films over the tooth structures exposed to the environment of the oral cavity and is susceptible to stain deposition by chromogenic bacteria.

STAINS OF CHROMOGENIC BACTERIA AND FACTORS OF ORAL HYGIENE

1. **Green Stain.** This stain is common in many mouths and is located on the labial surfaces of anterior teeth and the buccal and lingual aspects of the posterior teeth in the cervical third of the crown. More prevalent in males than in females, it appears heavy gray-green, soft and "furry." Crescentic light-yellow green thin lines often characterize this stain with rough and pitted enamel surfaces beneath. The green stain may cover longstanding areas of decalcified enamel, and is associated with poor oral hygiene.

In cases of poor oral hygiene, Nasmyth's membrane is stained by blood pigments arising from "bleeding gums" resulting from gingival inflammation. Blood pigments break down into sulfmethemoglobin yielding a green pigment, which overlies the teeth in the cervical (gingival) third.

Chlorophyll of dental plaque has been implicated in green staining. Foods and chromogenic bacteria such as *Bacillus pyocyaneus* (leading to "garlic breath" often associated with

this green stain) and fungi such as *Aspergillus* and *Penicillium glaucum* are suspected of playing a major role in the cause. Quantitative and qualitative analyses of the stain yield copper and iron as the most prevalent ions established in the stain.

2. **Brown and Black Stains.** The action of bacterial enzymes leads to a deposition of salivary mucin on the teeth, which is available for staining. The stains often occur proximal to salivary gland ducts and are pellicle-like, thin and brown. Located on the lingual and proximal of maxillary teeth and in the gingival third and occasionally on the labial, these stains are related to calculus and dental caries, as evidenced by the high caries incidence in stained developmental grooves, pits and fissures of the occlusal surfaces of posterior teeth and lingual surfaces of anterior teeth.

Black stain is exhibited as a fine black line of 0.5 to 1.0 mm in width, apical to the free gingiva and following the gingival contour in the cervical third of the crown of the tooth. As in the case of brown stain, it is frequently found next to the excretory ducts of salivary glands but is associated with adults and children possessing a *lower* caries incidence. A plaque of brown or black dots coalescing cervically on teeth, and known as the "Mesenteric Line," is also associated with caries resistance.

The etiology of these stains is unknown for certain although it may be related to a chromogenic bacterial deposit in salivary mucinous films present on the teeth. Analysis of brown stain yields stannous and chloride ions, which differs from the analysis of green stain, chemically, which yields aluminum, barium, nickel, boron, copper, titanium, strontium and potassium. Brown stains are fairly resistant to chemical agents; they are related to the enamel cuticle and give positive protein tests.

Black and brown stains are generally present in clean mouths. Brown stain tends to be somewhat easier to remove than black but both stains, while harmless, tend to recur.

3. **Orange Stain.** This stain is very much associated with poor oral hygiene and dental plaque. The general location for orange staining is the gingival third of the labial and lingual surfaces of anterior and posterior teeth where it appears as a light, thin deposit ranging in color from bright red to orange.

While there is still some speculation as to the origin of orange stain, there is a suggestion that it may be due to a pigment-producing microorganism. Cultures of orange stain samplings yield colonies of *Bacillus prodigiosus, Bacillus Rouge de Kiel, Bacillus mesentericus ruber, Bacillus roseus, Sarcina rosea* and *Micrococcus roseus*.

The common denominator in orange staining and green staining of teeth seems to be poor oral hygiene. Black, brown, orange and green stains are harmless in all aspects, except cosmetically. They can all be removed by regular oral prophylaxis with flour of pumice and green and orange stain should not recur once conscientious oral hygiene regimens are initiated.

STAINS OF EXTRINSIC DISCOLORING AGENTS

1. **Foodstuffs.** These stains are usually temporary and are the result of the immediate masticatory release of discoloring agents from foods and beverages. Frequently the full crown of every tooth is tinted the characteristic color which is derived from a familiar source. For example:

Source	*Color*
Black cherries, raspberries	Black, blue
Boysenberries, raspberries, beets	Red, purple
Red peppers, safran	Red and yellow films
Licorice	Black
Betel and areca nuts	Mahogany stains
Coffee, tea, cola	Brown

In some instances, the staining may last several months, providing a protective film over the enamel surface. Chewing leaves and berries of the pihu and nashimandi plants will leave a *black* stain of this nature.

2. **Tobacco.** It is hoped that in children we would not see tobacco staining very frequently. Nevertheless, there are some young smokers, and their teeth may sport the brown to black residues of tobacco tars and resins. In the cigarette smoker these are light brown and appear powdery whereas in the cases of pipe smokers stains are dense, black and tarry.

While tobacco stains are harmless and removable with pumice, they may prove to be gingival irritants and are, certainly, esthetically unpleasant.

3. **Restorative Materials.** Dental restorations of silver or copper amalgams do cause stain-

ing, especially in younger teeth which possess patent dentinal tubules which readily acquire any stain. The amalgam stains are green-black and bluish-black, and are products of the reactions of silver or copper ions of these restorative materials with sulfides present intraorally.

4. **Medicaments.** Precipitates of metallic and non-metallic compounds, such as ammoniacal silver nitrate ($AgNO_3$) reduced in eugenol and used as an agent in the arrest of caries always leaves an unsightly gray-black precipitate on teeth. This preparation is employed rarely today, but primary teeth, which will be exfoliated early in life, are more often treated with it than are permanent teeth. Silver particles may be demonstrated in histologic sections of dentine and pulp after silver nitrate administration. The medicament is distributed into carious tissues; eugenol will leave a superficial layer of black precipitate in the dentine and below this will appear a brown-stained layer of carious dentine (as a result of the reduction of $AgNO_3$ by the carious matrix), yielding a free silver colloid which is brown in color. The zone below this is composed of stain-free, sclerotic dentine and the deepest zone appears black as a result of reduced silver globules in the dentine tubules and cells of the vital pulp.

Brown to black staining caused by iron sulfide preparations is associated with dental plaque. This staining is noted during and after treatment of childhood microcytic hypochromic anemias with oral iron (Fe) solutions.

Ferrosol and ferricin are iron preparations administered to the child *post-prandially* to avoid gastric irritation. They are optimally utilized when prescribed between meals. Ferric ammonium citrate should be taken through a straw, however, to avoid dark staining of the tooth enamel.

Saki and iron filing are also a cause of black tooth staining, which is thought to be cosmetic by the Japanese.

Carious surfaces exposed to high concentrations of stannous fluoride (topically) exhibit pigmentation depositions. Non-carious areas are not discolored.

5. **Industrial Dusts and Proprietary Health Aids.** In patients exposed for long periods of time to the air-borne particles of metallic and non-metallic industrial dusts, the teeth exhibit very characteristic color changes caused by the incorporation of these substances into the enamel. For example:

Agent	*Color*
Fe, Mn, Ag	Black
Hg, Pb	Grayish
Cu, I, Br	Brownish
Cu, Sb, Ni	Green, blue-green
Hg, HNO_3	Cervical pellicle of green to green-black
Chromic acid	Deep orange
Cd	Cervical line after 2 years exposure–bright yellow
I-Lugol's solution	Lingual of mandibular teeth-brownish
$KMnO_4$ (mouthwash)	All teeth affected-deep violet to black
Locally applied antiseptics	Green, red, orange
Mercurial salts mercurochrome metaphen merthiolate	Green, red, orange
Para-amino salicylic acid	Green, red, orange, yellow

INTRINSIC STAINING

Any agent of coloration entering the dental hard tissues or causing structural alteration in the dental hard tissues with resulting color compromise (such as hypoplasia or aplasia of dentine or enamel) through a systemic route, can be considered an intrinsic staining factor. Enamel and dentine structural modifications of a genetic nature are included in this category.

Blood-borne Pigmentations

Congenital erythropoetic porphyria, a systemic disease resulting from an inborn error of metabolism, is a source of tooth discoloration from yellow to red-brown or purple-brown. Patients exhibit vesiculobullous lesions on exposed areas of the body which lead to scarring and deformation, along with photosensitivity, hemolytic anemia, splenomegaly, brown skin and red urine, the latter two caused by the high concentration of Type I and II hematoporphyrin pigment distribution in the blood and urine.

Bone and teeth especially concentrate the hematoporphyrin pigment and the primary dentition characteristically exhibits a reddish-brown discoloration throughout, known as "erythrodontia." The teeth are normal in form, but appear pinkish-brown with variations anywhere from yellow to bright red, or occasionally pink to purple shades.

The dentine, enamel and cementum are all affected and this has been documented through microscopic fluorescence studies. Deposits of por-

phyrin appear along dentinal incremental lines, and the teeth fluoresce red under ultraviolet light. This discoloration can not be removed.

Another inborn error of metabolism, due to a recessive gene, is Alkaptonuria, also known as ochronosis or phenylketonuria (PKU). Brown discoloration of permanent teeth may accompany the more common diagnostic dark pigmentation of bone, joints, sclerae, ear and nasal cartilages.

COLORING AGENTS ASSIMILATED INTO DENTAL HARD TISSUES

The hemolytic anemia of the fetus or newborn, erythroblastosis fetalis (Icterus gravis neonatorum; morbus hemolyticus neonatorum) caused by the transplacental transmission of maternal antibody to Rh factor (Rh incompatibility) leads to fetal jaundice accompanied by primary tooth staining and specific enamel hypoplasias.

In these cases of fetal jaundice, surviving children may have yellow-green, green to bluish-green, yellow, brown or gray stains located incisally or occlusally (with normal tissue coloring gingivally) in the primary dentition.

Central incisors display total green discoloration whereas lateral incisors, canines and molars are only partially discolored. In these teeth, histologic data reveal blood pigments such as biliverdin (oxidized bilirubin) deposited in enamel and dentine; thus developing teeth exhibit green, brown and even blue hues.

Severe disease in the infant is accompanied by enamel hypoplasia demonstrated at the incisal edges of anterior teeth and mid-crown on canines. There is a defect appearing "ring-like" and cervically on the tooth (indicating an absence of enamel formation) known as the "Rh Hump." Neonatal line duplication occurs frequently.

Not every child sustaining erythroblastosis fetalis will show the typical staining pattern in the primary dentition. In two German studies and one British study, 67 per cent, 50 per cent and only 10 per cent of subjects, respectively, show the discolorations.[4]

Treatment of this dental manifestation of the hemolytic disease is unnecessary as there is fading of the staining as the child matures and teeth developing post-partum or post-hemolytic insult (or portions of teeth developing after the occurence) are not involved at all.

Other hemolytic diseases, such as Thalassemia and sickle cell anemia (both of which are hereditary, whereas erthroblastosis fetalis is congenital) will exhibit similar dental lesions. Should these diseases occur in early childhood, the permanent dentition will be discolored and the primary dentition unaffected.

Bile Duct: Iatrogenic Factor

Hyperbilirubinemia, produced by the ligation and reflection of the main bile duct leaves some cases of biliverdin present in pre-dentine and pre-enamel. Often, biliverdin is found in the dentine itself and irregular pre-enamel deposits are present. Since this is, again, an instance of a pigment produced by blood breakdown products, the characteristic color range from yellow to green, to blue, brown and gray would be typical.

Bile Duct: Congenital Defects

Bile pigments (in these cases where the child suffers from a congenital bile duct defect) will discolor the primary teeth. The characteristic color is green and it is heavily concentrated in the middle to gingival third of the crown, with a yellowish gradation upward to the incisal and occlusal surfaces of the crown. The roots of these affected teeth are especially green, probably since cementum, which covers the root surface and is superficial to the dentine of the anatomic root, readily acquires stain and because dentine (deep to the porous cementum) itself stains extensively.

Neonatal Hepatitis

Blood and bacterial pigments are precipitated in the pulps of teeth of neonatal hepatitis victims. Bilirubin, especially, penetrates through the dentinal tubules into secondary dentine (the sclerotic dentine laid down as a response to injury, such as caries). Through oxidation of the bilirubin released, biliverdin, which is green, is formed, imparting this color to affected teeth. Primary teeth are discolored yellowish-brown due to the incorporation of bilirubin into enamel and dentine.

Traumatic and Inflammatory Defects

Should the child sustain a traumatic or in inflammatory in-

sult to a tooth or teeth, a blue-black discoloration will result. In addition, this discoloration, due to the blood breakdown pigments, hemin and hematin, will occur in teeth of children with certain blood dyscrasias. Other pigmentations, such as red-brown orange or green discolorations occurring post-trauma or post-inflammation, are due to methemoglobin, hematoidin and sulfmethemoglobin, respectively.

Following traumatic injuries to the teeth there may be evidence of loss of the normal crown structures, and a concomitant loss of translucency. Pulpal hemorrhage (which is temporary if the pulp survives the incident) results in extravasated blood present in the crown. Erythrocytes of this pulpal hemorrhage undergo lysis, hemoglobin is released, the breakdown products hemosiderin and hemotoidin then will enter the dentinal tubules causing the crown to appear darker. In the event that the pulp does not undergo necrosis, the crown of the tooth will return to "normal" coloration within 3 to 4 weeks after the injury. Discoloration evident months or years post-trauma is indicative of pulpal necrosis, and the child should be administered the appropriate treatment (endodontics or pulpotomy) to maintain the tooth as a non-vital organ wherein debridement of infective agents has taken place in order that the tooth preserve esthetics, function and space maintenance.

Another source of "coloration" of the tooth, or teeth of a child having undergone a local traumatic or inflammatory injury, is called "enamel pink spot" or resorption. Resorption of the dental hard tissues may be external (peripheral) or internal, meaning they may arise from inside the tooth or from outside the tooth. It is believed now that autoimmune factors may trigger some of the unexplainable external resorptive patterns that have been documented.

"Pink spot" is an adequate description of the appearance of the enamel during internal resorption, since there is an actual removal of dentine from within the tooth by vascular resorbing tissue which is visible through the enamel, and appears pink to reddish-brown in the center of the crown or cervically. External resorption, possibly caused by an idiopathic hyperplasia of the periodontal ligament, (an important member of the dental attachment apparatus) is manifested as a peripheral "pink spot." This may follow acute trauma to the tooth and apical vessels; for example, occlusal traumatism, and orthodontics (controlled occlusal traumatism) will often present external resorption as a sequela of treatment. Usually 8 to 10 months after the initial appearance of the "pink spot," the crown is perforated.

Fibrosis, asceptic pulpal necrosis and degeneration of the pulp will leave the affected tooth with gray or black coloration. Hemorrhage and incomplete root canal debridement during pulpectomy (an endodontic procedure) may also impart a black or gray hue to the tooth.

Congenital Heart Disease

A study on cyanotic heart disease in children conducted by Finnish investigators gave the following results: (1) 50 per cent of the children had abnormally pale maxillary incisors; and (2) The color was specifically a bluish-white (skimmed milk) hue.[4]

The supposition followed that this "tooth pallor" might be attributed to the poorly oxygenated blood these patients possessed and that mouth breathing, prevalent in these children, could cause drying of the teeth sufficient to sustain this color change.

Typhus and Cholera

Rare, but nevertheless worth mentioning is that typhus and cholera victims may exhibit pink discoloration of the teeth.

Dental Caries

Since dental caries is one of the more prevalent diseases of civilized man, and since the "tooth ache" or symptoms of odontalgia indicative of pulpal necrosis or pulpitis are body defense warnings of inflammation or infection that must not be neglected, the pediatrician should be able to recognize gross clinical carious lesions in their young patients' teeth. The actual treatment and restoration of carious teeth is relegated to the dentist, but pediatricians, who tend to see the child well before the child sees the dentist, should inform the parents of deleterious dental changes, in order to initiate treatment, restoration and control of further dental disease.

Enamel caries appear white, chalky and roughened as opposed to smooth enamel opacities. With sufficient destruction of enamel, the underlying dentine is involved such that a brown to black staining of the dentine is obvious. Arrested caries appear dark in color, but upon examination with an explorer, they will not have a soft consistency.

"Acute" dental caries, best described as exposed dentine appearing almost "dished out" without a covering of enamel, or with an extremely undermined and unsupported shell of enamel surrounding, will be brown-yellow in color due to melanin.

Melanodontia, rare in the United States but seen in Africa and the Orient, is an ebony black discoloration of the teeth resulting from unusual dental caries. This blackness is attributed to the pigment hematin, from bacteria present in the pulp and dentinal tubules (iron has been demonstrated in qualitative analysis of melanodontia specimens). Primarily, this condition affects the primary dentition, especially the middle third of the crowns of maxillary incisors.

Another type of decay affecting the primary dentition is termed "odontoclasia." This appears as a circular type rampant decay and the etiology is ameloblastic damage. A disturbance in amelogenesis is depicted in these affected primary teeth by an incremental band where decay will occur.

Ionizing Radiation: Erupted Teeth

Caries-like effects are noted on fully erupted teeth present in patients having received irradiation of the salivary glands. Xerostomia is a consequence of such irradiation, and caries-like lesions will appear in the cervical regions of present teeth. These lesions are hard and discolored; very often attrition and fracture of the crown will occur leaving discolored roots. In some cases there is a complete brown-black discoloration of the crowns of these erupted teeth. The stain penetrating the enamel is not removable and is accompanied by rapid wear of incisal and occlusal surfaces.

Ionizing Radiation: Developing Teeth

Keeping in mind that both primary teeth and permanent teeth may be considered "developing" or "unerupted" teeth depending on the age of the child, it is important to consider the possibilities of resulting lesions for each of these dentitions should the child be exposed to irradiation.

Primary tooth lesions are rare and are only present if the embryo or fetus was irradiated *in utero*. The most common abnormality noted for the primary dentition in this case is delayed eruption.

Permanent teeth, on the other hand, will exhibit several types of defects if the developing tooth bud was exposured to radiation.

Secondary necrosis of the tooth germs leading to anodontia (absence of teeth) or hypodontia (less than normal number of teeth) can occur. In addition, microdontia, premature calcification and eruption, absent roots, abnormal or retarded root forms and premature calcification and eruption of the teeth are common. Hypoplasia of the enamel accompanied by brownish staining may be observed. This last *intrinsic* effect is rare in developing teeth.

Abrasions

Abrasions of the teeth will lead to exposure of dentine. Abrasion resulting in this exposure of dentine cause discolorations of the teeth ranging from dark yellow to brown. Loss of translucency of the tooth is due to protective changes, such as dentine sclerosis in the pulp chamber or root canal (the "laying-down" of secondary dentine) when the dentine is exposed or endangered. Physiologic yellowing or darkening as the pulp chamber is obliterated by these protective changes of the dentine is found much more routinely in older patients.

Denudation of the dentine, which is an exposure of dentinal tubules subsequent to fracture, attrition, erosion or abrasion, allows the entrance of coloring agents (mentioned initially in this paper) into the tubules of dentine. Brown or yellow discoloration at the denudation sites is common.

Food coloring and tobacco stains will readily gravitate to infraction areas (areas of incomplete crown fracture where the openings into dentine are minute). A variety of colors can be noticed in these locations.

Sand scratches will leave the tooth with irregularities in its surface, whereas carborundum particles usually will leave clean surface cuts. Rough irregular pits are the result of chalk

bombardment of the teeth. The important thing to remember about these three abrading agents is that any staining material can and will enter the openings left following exposure of the teeth.

Erosion

The term "erosion" implies the loss of calcified tooth structure using chemical means, such as acid etching with citrus juices, vomiting (hydrochloric acid), and foods.

Decalcified enamel appears as a "white spot," where the enamel remains hard and intact, becoming progressively smoother, harder, glass-like and polished until the underlying dentine is exposed revealing a yellow-brown coloration.

ENDEMIC FLUOROSIS

When the childhood drinking water contains greater than 1.5 ppm of fluoride, there is danger of clinical fluoride intoxication resulting in hypocalcification and mottled enamel. This is acquired systemically in developing dentitions, having a higher frequency of occurrence in the permanent dentition, and appearing symmetrically in the dental arch.

Cryolite studies in Denmark demonstrated the systemic assumption of fluorides in the child even while nursing. Topical fluorides applied to erupted teeth *cannot* cause fluorosis, as the lesion is based on systemic intoxication.[4]

Endemic fluorosis is actually a change in the dental hard tissues reflected in their structure and thickness. Mottled enamel may be present. Cases range from mild, where the enamel appears opaque (chalky, white) with a normal hard surface, to severe, where there is loss of enamel strength, pitting, and discoloration of the tooth from yellow to brown.

The teeth appear lusterless and opaque with white patches. Depending on the severity of the case the teeth may be mottled, striated and pitted. At the time of eruption, brown stain is not present, but since the brown stain is basically extrinsic from pigmentations entering the hypoplastic enamel areas, they are removable. Much of the staining in endemic fluorosis appears as diffuse cloudiness and spotting with white flecks. Linear stains are yellow-brown and most ill-defined patches are brownish-black. Hypoplasia of the enamel is rare in endemic fluorosis, but when present, deep, irregular brown pits will also occur.

The dental changes characteristic of endemic fluorosis are most marked on the labial surfaces of maxillary incisors with accentuation or perikymata and evidence of multiple pits. The teeth affected (in ascending order) are:

(1) Mandibular incisors
(2) First molars
(3) Canines
(4) Maxillary incisors
(5) Second Molars
(6) Premolars

Prevention of clinical intoxication is accomplished through *controlled* fluoridation of water supplies. Depending on the climate (hot or cold) there is an optimal decay preventive level of fluoride for the water supply. For example, 0.8 ppm and 1.2 ppm fluoride for hot and cold climates, respectively, are considered levels capable of preventing decay, but below the fluorosis point.

The extrinsic staining found in hypoplastic, pitted areas of affected teeth is removable by isolation of the tooth, thorough drying of the area and topical application of 30 per cent hydrogen peroxide solution with gentle heat. Several treatments of this type may be necessary to produce favorable results.

Drug Administration: Tetracycline

Children treated very early in life for diseases of an immune-deficient nature and youngsters suffering from infections during their neonatal period undoubtedly have benefited from antibiotic therapy. Tetracyclines, the broad spectrum antibiotics used almost indiscriminately for the treatment and prevention of infections, may result in dental anomalies if used during the period of tooth formation when appositional growth occurs.

Tetracycline staining of teeth is fairly common and well recognized. In severe cases, hypoplasia of the enamel will accompany the color changes (blue, gray-brown, yellow) resulting in teeth developing during administration of the drug. Tetracycline will affect any tissue undergoing the process of mineralization concurrent with its administration. Calcium orthophosphate tetracycline complexes are the products of a reaction involving body calcium ions and tetracyclines. The tooth color changes correlated with the

Because all water is not the same, the vitamin-fluoride combinations pediatricians prescribe may not be serving your patients well.

The first time you see one of your pedodontic patients, he may be taking a vitamin-fluoride supplement prescribed by his pediatrician.

The amount of fluoride in these combination products cannot be easily adjusted to the varying degrees of fluoride in your patients' drinking water. The result may be a patient who is receiving too much or too little fluoride—or an incorrect dose of vitamins. This is why vitamin-fluoride combinations are not accepted by the American Dental Association or other dental authorities.[1]

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Contraindications: LURIDE Lozi-Tabs are contraindicated when the fluoride content of drinking water exceeds 0.3 ppm F. LURIDE Half-Strength Lozi-Tabs and LURIDE Drops are contraindicated when the drinking water contains 0.7 ppm F or more. *Precaution:* Recommended dosage should not be exceeded since prolonged over-dosage may result in dental fluorosis. *Administration and Dosage:* When drinking water contains 0 to 0.3 ppm F: age three and over—10 drops or one tablet daily; under age three—5 drops daily. When drinking water contains over 0.3 but less than 0.7 ppm F: age three and over—one 0.5 (half-strength) tablet daily or a reduction in dosage of drops by one drop for every 0.1 ppm F in the water; under age three—one-half the drop dosage of older children. *Supplied:* Drops: 40 ml. drop-delivery plastic bottle. Lozi-Tabs chewable lozenge-type tablets: bottles of 120; bottles of 1000 and 5000 for dispensing only, available in cherry, lemon, lime, orange and rainbow assortment flavors. 0.5 Lozi-Tabs tablets (half-strength): bottles of 120, bottles of 1200 for dispensing only, grape flavored.

[1]*Accepted Dental Therapeutics 1973/74*, 241-242
[2]Aasenden, R., and Peebles, T. C.: Effects of Fluoride Supplementation from Birth on Human Deciduous and Permanent Teeth. *Archs. Oral Biol. 19*:321-326, 1974
[3]Mellberg, J. R., Nicholson, C. R., and Law, F. E.: Fluoride Concentrations in Deciduous Tooth Enamel of Children Chewing Sodium Fluoride Tablets, *Journal of Dental Research 51* 551-554, 1972.

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specific drug administered are as follows:

(1) Chlortetracycline (Aureomycin)-Gray-brown
(2) Dimethylchlortetracycline (Ledermycin)-Yellow
(3) Oxytetracycline (Terramycin)-Yellow, least discoloring
(4) Tetracycline (Achromycin)-Yellow
(5) Doxycycline (Vibromycin)-No change

Ninety-eight per cent of subjects given tetracycline during the neonatal period (including premature infants) showed tetracycline complications ranging from enamel hypoplasias to yellow or brown tooth discoloration or both. Interestingly enough, the location of tooth discoloration on the crown of the tooth coincided with the developmental stage of that portion of the tooth at the time of tetracycline ingestion. Thus, similar to radioactive fluoride tracing, tetracycline may be used as an indicator for odontogenesis or for the rate of hard tissue development in general. In the case of tooth discoloration, odontogenesis determines the location and distribution of the stain.

In prescribing medication during pregnancy, tetracyclines are contraindicated from week twenty-nine of pregnancy until term. High risk period is from 7 months *in utero* until 7 to 8 years of age. The dosage time, length of administration and homologue of tetracycline will determine whether or not discoloration will occur. For example, 21 mg tetracycline/kg bw/day will produce discoloration. Fetal concentration of the drug *via* transplacental assumption of the tetracyclines may be two-thirds that of the mother's. Permanent teeth are less intensely but more diffusely affected than are primary teeth. The character of staining appears to change with time: brownish coloration often resembles "fading" or aging of yellower staining. Yellow usually becomes dark gray or brown in both primary and permanent dentitions. As the teeth receive progressively more and more exposures to light, any discoloration from existing tetracycline will darken.

Affected teeth will fluoresce bright yellow under ultraviolet light; the fluorescence patterns in dentine are more extensive than those in enamel, and bands of fluorescent material have been demonstrated in ground sections of dentine.

Recently, a technique was developed to attempt correction of these tetracycline stains employing a preliminary prophylaxis and isolation of the affected teeth and subsequent applications of hydrogen peroxide and sodium perborate solutions used in conjunction with heat. These treatments may require repetition several times and careful documentation of tooth vitality (considering that heat is being applied directly to the tooth).[1]

Turner Tooth

Localized (as opposed to systemic) insults occurring during tooth development (odontogenesis) may cause disturbance in enamel formation, such that cementum (normally occurring on the anatomic root of the tooth) is deposited on the crown in areas of deficient enamel formation. Since the cementum is porous in character, exposure to the oral environment after the tooth is erupted into the oral cavity will lead to ready discoloration of the cementum replacing the deformed enamel. Yellowish-brown staining is seen in these "Turner teeth" due to cementum exposure to food coloring and chromogenic bacteria.

Infection and trauma locally, such as that caused by periapical infection of a primary tooth, mechanical injury to a permanent (succedaneous) tooth bud or any infection surrounding a tooth germ may cause total or partial arrest in tooth formation, alignment displacement of the tooth related to the crown and root, smaller than normal crowns, or enamel hypoplasia (such as premolars affected by primary molars). In areas of the crown where enamel is lost, the enamel begins as thin and irregular in quality. In addition, dentine quality may be abnormal. Prior to eruption, cementum will fill this defective enamel area and eventually color changes (yellow-brown) will be demonstrated.

Amelogenesis: *Enamel Development*

The enamel of the primary tooth develops partially prior to and partially after birth. The boundary delineating these two chronological divisions in primary tooth odontogenesis is indicated by an accentuated incremental line of Retzius. (An individual line of Retzius is a layer of enamel *matrix*; lines of Retzius, therefore, are layers of enamel matrix successively appositioned during odontogenesis, similar to the annual rings

of a tree.) This "dividing" line of Retzius, known as the Neonatal Line or Ring is the result of the abrupt change of environment and nutrition of the newborn infant: prenatal enamel is better-developed than post-natal enamel.

Possible pathologic changes which may occur during amelogenesis affect matrix formation, maturation or both. These are known as hypoplasias or hypocalcifications, respectively.

Pitting, furrowing or entire absence of enamel indicates change of a *hypoplastic* nature, whereas chalkiness or opacity with normal enamel surface contour reflects pathology affecting mineralization of the pre-existing matrix, or *hypocalcification*. Causes for pathology of amelogenesis may be systemic including nutritional or endocrine deficiencies, fevers, chemical intoxication, local causes, (such as mentioned in the earlier discussion of Turner teeth) or etiology based on genetics.

Amelogenesis Imperfecta: *A Disturbance of Matrix Formation*

Hereditary enamel hypoplasia (brown hypoplastic enamel, brown teeth, enamel aplasia) indicates a generalized disturbance of ameloblasts affecting the teeth of *both* dentitions. This pathologic change is transmitted *via* a Mendelian dominant gene and grossly the result is thin enamel, appearing yellowish-brown, smooth and glossy.

There is an accompanying tendency toward tooth impaction due to defective reduced enamel epithelium (which contributes to the normal eruption of all teeth). In amelogenesis imperfecta, the reduced enamel epithelium is abnormal. Another tendency these teeth exhibit is peripheral resorption. Oddly enough, amelogenesis imperfecta teeth will be rather caries resistant. The dentine structure is *normal*.

Hypoplastic-Type Enamel Aplasia

Males exhibiting this type of amelogenesis imperfecta will have hard but thin, smooth enamel whereas the enamel of females will be thick with vertical grooving, pitting and wrinkling. (Hereditary disturbances result in diffuse or *vertical* anomalies in tooth structure, where environmentally based anomalies are *horizontal*.) *Hypoplastic* enamel implies that mineral salt uptake is *normal*, but with an abnormal enamel *matrix*. Therefore, attrition may be rapid, thin enamel may be present and pitting and wrinkling of the enamel surface may eventuate in yellow or brown staining from extrinsic sources.

Hereditary Hypomineralized Type Amelogenesis Imperfecta

This implies the presence of an adequate matrix of enamel which has failed to mature fully. This breed of amelogenesis imperfecta is more common than the hypoplastic type, occurring more frequently. Nail defects may accompany the simultaneous enamel defects in both hypoplastic and hypocalcified amelogenesis imperfecta.

In the hypomineralized type, shortly after eruption the crown possesses a normal shape but there is a dullness or lack of luster in the enamel, so that the enamel appears almost opaque. Discoloration may follow rapidly; the teeth are susceptible to wear and abrasion. The enamel appears almost nonexistent on radiographic examination (due to a low concentration in mineral salts) and eventually the "soft" enamel is lost, chipped and worn away leaving small, brown "teeth" (actually exposed dentine). Enamel fractures occur due to the chalky consistency imparted to the hypocalcified enamel structure. Any remaining enamel is uneven and soft at the surface due to the mineralization disturbance and will appear dark brown or orange once food stains are assimilated from the oral cavity.

Non-Hereditary Enamel Hypoplasias

Non-genetic factors (disturbances) occurring during matrix formation and mineralization of the enamel structure may be associated with macroscopic defects in the enamel surface. Interferences may be systemic or local and result in tooth defects occurring contralaterally in the dental arch. Turner tooth is the result, again, of a localized insult. The chronology of tooth formation at the time of the disturbance will be reflected in the resulting appearance and location of the pathology. It is well to keep in mind that both acute and chronic conditions insulting the child systemically may cause these changes in amelogenesis.

Damage to the enamel is irreversible; very often, breaks in enamel continuity become seats of secondary discoloration.

Since it has been established that the systemic insult can be dated by the location and character of the resulting tooth damage related to chronology of tooth formation, neonatal hypoplasias may be considered in-

sults resulting in death of ameloblasts incisal to the neonatal line, exposing pre-natal enamel at the surface of the tooth but not cervical to it. Younger ameloblasts will survive and continue to lay down enamel matrix.

Premature infants sustaining health disturbances during the initial weeks of post-partum life or children suffering exanthemous fevers at a very young age often will display teeth with hypoplastic pits and grooves in a horizontal arrangement.

In pre-natal syphilis cases, Hutchinsonian teeth will frequently exhibit defective or nonexistent enamel or even root dwarfing.

A sample of 40 children suffering the edema, proteinurea, decreased concentration of plasma proteins and hyperlipemia characteristic of Nephrotic syndrome revealed permanent dentitions with enamel hypoplasia in 40 per cent of the subjects. Children with renal disease prior to 6 years of age will possess faulty enamel formation correlating with the actual onset of renal disease.[4]

Enamel hypoplasias are common in children with celiac syndrome and hyperthyroidism. Cerebral palsy youngsters very often will have defects in their enamel of a hypoplastic nature accompanied by changes in the natural or more normal courses of the enamel prisms. The neonatal line may also be thickened.

Morquio's Syndrome, a clinical chondrodystrophy caused by acid mucopolysaccharidosis *via* an inborn error of keratosulfate metabolism, will yield corneal opacities, aortic regurgitation, urinary excretion of keratosulfate and dental abnormalities. Carious dull gray aplastic enamel which "flakes off" is the typical dental picture in these children.

CONGENITAL SKIN DISEASES

Hereditary Epidermolysis Bullosa

There are three varieties of Hereditary Epidermolysis Bullosa, namely the lethal, dystrophic and simplex types. Dental hard tissue changes occur in the lethal and dystrophic types.

In the dystrophic category, the teeth have a hypoplastic appearance, exhibiting enamel surface pitting. The roots are "folded." Incidental bullous lesions of the oral cavity accompany these dental abnormalities.

Lethal hereditary epidermolysis bullosa patients reveal similar changes; along with victoms of the dystrophic type, the enamel organ shows metaplastic changes (stratified squamous epithelium rather than columnar) at the commencement of dentine formation. Hypoplastic changes in the dental hard tissues similar to those seen in amelogenesis imperfecta are observed in this disease.

Congenital Ichthyosis

The more common type of congenital Ichthyosis, *Ichthyosis vulgaris*, is caused by an autosomal dominant gene. After three months of age, the child is afflicted with shiny hyperkeratosis of the elbows, knees, and ankles. Deformities of the maxilla and mandible may occur, as well as malpositioning of the teeth on eruption. Dental changes specifically include delayed tooth eruption dilacerations (apical bending of roots), resorption of mesial roots of molars, ankylosis and an emphasis of the neonatal line in the dentine coronally. The carious process is usually marked.

Metabolic and Infective Disturbances

Hypoplastic changes in the dental hard tissues will often result from the following diseases: 1. Cleidocranial dysostosis, where there is a marked retention of the primary dentition related to delayed eruption of the permanent dentition; 2. Osteogenesis imperfecta; 3. Osteoporosis; 4. Calcinosis; 5. Diseases associated with disturbances of calcium metabolism such as Tetany, Vitamin D deficiency, Deficiencies of Ca^{++} and $PO_4^{\equiv}$ Rickets; this is a clinically distinctive disease in that the hypoplasias will occur pathognomonically in the first permanent molar and the tips of the canines: Vitamin C deficiency (Scurvy), Hypoparathyroidism.

CHRONOLOGY OF TOOTH FORMATION

Systemic insults to the patterns of matrix formation and mineralization of both dentitions can be dated.

The diet of the mother prior to parturition will affect the child's primary dentition in this way. Should two-thirds of the permanent dentition exhibit enamel hypoplasias, the origin of the systemic insult took place during the child's first ten months of life *post-partum*. The permanent teeth affected are first molars, incisors (excepting maxillary laterals) and canines. The *mesial cusps* of the first

molars are unaffected since they mineralize prior to birth.

In one third of cases involving disease affecting mineralization and matrix formation, the insult takes place between the eleventh and thirty-fourth month of age. *This* will affect the maxillary lateral incisors and maxillary premolars.

Two per cent of cases occur at 35 to 80 months of age and in these instances, second permanent molars are affected.

Yellow Hypoplasia of the Teeth

A common hypoplasia of the enamel which is of concern to both parent and child is yellow hypoplasia of the enamel. This sign is not confined to the enamel, actually, but rather affects all of the dental hard tissues such that the entire thickness of dentine and enamel possess yellow- to yellowish-orange discoloration. Involvement of both posterior and anterior teeth is equal.

Most of these cases of "yellow teeth" are associated with a family history. The teeth affected are less resistant to abrasion and attrition than are unaffected teeth and the enamel tends to splinter off vertically and flake. The teeth appear to have a narrower buccolingual diameter and a reduced vertical height due to abrasion and attrition. Roots of these affected teeth will manifest a yellow to yellow-orange coloration.

Rubella-Associated Hypoplasias

Rubella during the second through fourteenth weeks of pregnancy may produce a range of defects in the child's dentition. These vary from isolated pits to enamel aplasia involving greater than half the crown.

The rubella infection persists in the neonate after the disappearance of rash and viremia in the mother, therefore dental hypoplasia of specific teeth does not necessarily reflect or coincide with the chronology of the mother's infection.

Enamel Opacities

These hypoplastic-type defects appear as white, opaque spots. The surfaces are usually smooth but also may be brown and *mottled*, and occur in both primary and permanent dentitions.

Maxillary incisors seem to be most frequently affected by enamel opacities. There is a lesser prevalence of these "lesions" in the mandibular arch. All four primary incisors are affected, if any are affected, but maxillary permanent centrals are more often affected than are the maxillary permanent laterals.

The etiology is related to a disturbance in (enamel) matrix formation where normal matrix is deposited following an insult, covering the affected area. This gives an opacity to the enamel.

Hypoplastic defects of the primary dentition include odontoclasia, a circular-type rampant decay caused by damage to the ameloblasts. The disturbance in amelogenesis is depicted by an incremental band.

DENTINOGENESIS

Hereditary Disorders

Changes in structure or thickness of the dental hard tissues affecting dentine, will often affect both primary and permanent dentitions.

Dentinogenesis Imperfecta (hereditary opalescent dentine, transparent enamel, *dysplasie de Capdepont*, hereditary dentine hypoplasia) affects both dentitions. The prevalance of this hereditary disorder is higher than that of amelogenesis imperfecta.

Osteogenesis imperfecta produces anomalies similar to those evidenced in dentinogenesis imperfecta featuring short teeth with bulbous crowns and dwarfed or shorter roots and over formation of dentine leading to obliteration of the pulp chamber. On eruption the teeth appear translucent with an opalescence and amber-like consistency. Eventually, they possess gray to brown to bluish enamel reflections. The enamel, which is poorly calcified, has a tendency to break away from the dentine.

It is important to remember that on eruption into the oral cavity, these teeth exhibit normal contours, and that due to the histologic changes occurring in dentine, including mineral deposition in the dentinal tubules, color changes from normal to translucent to brownish. Pulp chambers become obliterated.

Treatment of these teeth which tend toward rampant decay is full coverage restorations.

Shell Teeth

Shell teeth are teeth possessing short roots and large pulp chambers radiographically. This anomaly is governed by the same gene affected in dentinogenesis imperfecta, except that in shell teeth, a dentine wall of normal thickness fails to develop. The peripheral dentine is normal.

Dentinal Dysplasia

"Rootless teeth" or "familial genuine malformation of roots" is an hereditary disorder appearing in the primary and permanent dentitions. It is characterized by early tooth loss due to marked mobility and a tendency toward periapical disease in these short-rooted teeth. Pulp chambers tend to appear eradicated with narrow radiolucent lines.

Prenatal Syphilis

Hypoplastic dentine has been observed in Hutchinsonian teeth.

DISTURBANCES AFFECTING BOTH PRIMARY AND PERMANENT DENTITIONS

Odontogenesis imperfecta is a hereditary disorder wherein dentinal dysplastic and enamel hypoplastic changes are seen in all teeth in both dentitions.

In *regional odontodysplasia* ("Ghost teeth," odontogenic dysplasia) there is a localized arrest in tooth development. Unilateral dental malformations are present with both enamel and dentine affected in several teeth per oral region. Primary and permanent dentition are affected with the primary dentition most affected.

Clinical features include eruption delays or lack or eruption, anatomic distortions of the teeth affected, and thin, yellow enamel. Demarcations between enamel and dentine are absent. The pulp chambers tend to be widened and the radiodensity of the teeth is less than normal.

Histories on these patients reveal no traumas or infections as possible etiology. It is possible that a somatic mutation is responsible for these very localized changes. Alternatively, it has been hypothesized that a viral-type "silent" infection of the enamel epithelium may be the etiological factor.

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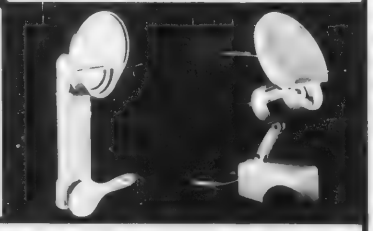

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Effect of Rinsing Time on Antiglycolytic Properties of Amine Fluoride Mouthrinses

M. M. Dolan, A.B., E. T. Harding, B.S., and S. L. Yankell, Ph.D.

In a clinical study, an amine fluoride mouthrinse containing a 1:1 ratio of hetaflur and dectaflur inhibited salivary glycolysis up to 90 minutes after rinsing for 30 seconds.[2] When added to broth, the same compounds at levels as low as 10^{-5}MF interfered with attachment of streptococci to nichrome wires.[5] One component, hetaflur, was more potent in preventing streptococcal deposits when the wire was dipped in test material, while the other component, dectaflur, was more potent when added to the growth media during the first 24 hours of testing.[3] These tests indicate that the mouthrinse components were acting by different mechanisms.

The purpose of this investigation was to test the individual mouthrinse components for antiglycolytic potency and investigate whether differences in rinsing time would influence duration of effects of the individual agents and the hetaflur:dectaflur combination.

METHOD

The active agent(s) in the mouthrinses tested are: (1) Hetaflur (hexadecylamine hydrofluoride) and dectaflur (9-octadecenylamine hydrofluoride) in a 1:1 ratio to supply 250 ppmF; (2) Hetaflur (hexadecylamine hydrofluoride) to supply 250 ppmF; (3) Dectaflur (9-octadecenylamine hydrofluoride) to supply 250 ppmF; (4) Placebo.

Ten volunteers rinsed with one mouthrinse preparation on each test day. Before rinsing, chickle-stimulated saliva was collected in beakers immersed in cracked ice. After the control samples were collected, each subject rinsed for 10 or 30 seconds with the assigned material. Saliva was again collected as described above at 15, 45 and 90 minutes after rinsing. All saliva samples were refrigerated until tested.

Glycolytic Activity Tests: Two ml of each saliva sample were pipetted into test tubes containing 0.5 ml of 5 per cent glucose and incubated at 37 C in a shaker water bath for five hours. Glycolytic activity was measured by recording pH at one hour intervals.

RESULTS AND DISCUSSION

Figure 1 shows that after 10 or 30 seconds rinse time with the 1:1 combination of hetaflur and dectaflur, antiglycolytic effects persisted to a significant degree, compared to the placebo rinse, for at least 90 minutes after a single rinsing. The individual components used for 30 seconds, although not presented in the figure, yielded similar results.

Figure 2 shows that after a 10 second rinse time, the combination of amine fluorides is effective to a significant degree for a longer period

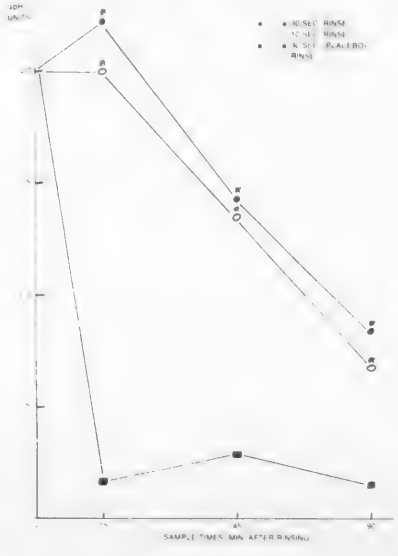

FIG. 1. 10 sec. *vs* 30 sec. rinse time with the combination hetaflur/dectaflur after 5 hours incubation at 37 C.

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than either component alone at the same concentrations (250 ppmF). All statistical comparisons are to the placebo mouthrinses.

As measured by pH changes, the mouthrinse containing hetaflur and dectaflur consistently produces antiglycolytic effects on human saliva which persist for at least 90 minutes after a single rinsing of 10 or 30 seconds. Rinsing for 30 seconds with either hetaflur or dectaflur alone is as effective as the combination. A shorter, 10 second rinsing time of the combination significantly decreases glycolysis for 90 minutes whereas the individual components were effective for only 45 minutes after rinsing.

SUMMARY

The combination of both amine fluorides appears preferable to using either compound separately. The amine fluoride mouthrinse, with hetaflur and dectaflur, had prolonged antiglycolytic activity on human saliva after a single rinsing for 10 or 30 seconds. After rinsing for 30 seconds with either component alone, similar results were seen; however, after 10 seconds rinse time, the combination was effective for a longer period than either component alone. The prolonged activity of the amine fluoride mouthrinse may be due to absorption into pre-existing plaque and bacteria,[4] or enamel surfaces with slow release into saliva,[5] or the effect may be due to hetaflur and dectaflur's ability to inhibit growth of salivary bacteria.[1] It would then be expected that after a 10 or 30 second rinse time with the amine fluoride mouthrinse, plaque accumulation with resultant acid production, which destroys enamel surfaces, would be inhibited.

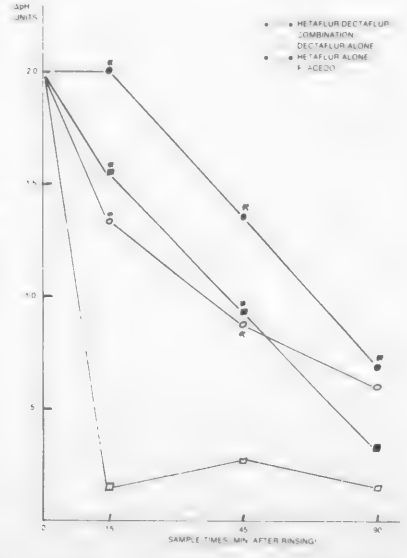

FIG. 2. 10 sec. rinse time with the combination *vs* separate components after 5 hours incubation at 37 C.

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Relationship of Dental Calculus and Periodontal Disease

A Review of the Literature

Stuart L. Fischman, D.M.D.,* Lewis Cancro, M.S.,** Morton Pader, Ph.D.,** and Anthony Picozzi, D.D.S.†

The potential for the reduction of periodontal diseases by the use of an effective anticalculus agent can, in part, be assessed by a review of the pertinent literature. In this review, the authors will present literature evidence bearing on the following: 1) the importance of periodontal diseases; 2) the etiologic role played by dental calculus; and 3) the potential benefits from an effective calculus preventing agent.

IMPORTANCE OF PERIODONTAL DISEASE

Periodontal disease is an inflammatory disease of the tissues and structures that invest and support the teeth. It is quite probable that this clinical pathologic state is a complex of diseases, rather than one single disease entity.[10] Authors have suggested that this clinical syndrome should be called "periodontal diseases" or "diseases of the periodontium." This concept has considerable scientific merit, but we will exercise literary license and use the singular noun in this presentation.

It has been estimated[36] that 20.1 million Americans are without permanent teeth in either of their jaws. An additional 2.8 million Americans have such neglected and/or diseased oral tissues that their teeth probably would be extracted if appropriate dental care were sought. The chief dental diseases responsible for almost 23 million edentulous or functionally edentulous Americans are dental caries and periodontal disease.

A U.S. Public Health Service study[39] conducted in 1948–1952, concluded that over age 35, periodontal disease is the controlling factor in tooth loss. In men over the age of 35 and women over the age of 40, periodontal disease has been estimated to cause two to three times more extractions than caries.[40] At all ages, in one private oral surgery practice, 20 per cent of all tooth loss was due to periodontal disease.[17] Another study[3] revealed that periodontal disease was the reason for extraction in 13 per cent of the patients, but accounted for 40.7 per cent of the teeth removed. The average patient with periodontal disease referred for extractions had to have in excess of ten teeth removed. These "mortality" studies indicate the magnitude of the disease in terms of tooth loss. As caries-preventive procedures, such as the use of fluoridated drinking water, become more prevalent, the relative significance of periodontal disease will increase.[40]

Morbidity studies have demonstrated the prevalence of "active" periodontal disease in the United States. The recent National Health Survey revealed that three-fourths of the persons with natural teeth showed some evidence of gingivitis and periodontitis.[33] Prevalence increased with age so that in the 75–79 age group nine-tenths of the subjects had periodontal disease. Destructive periodontal disease was found in one half the sample at this age group. Three-fourths of the entire adult population had periodontal disease.[34] One-fourth had destructive periodontal disease and one-half had a diagnosis of mild to severe gingivitis. The editors of the National Health Survey concluded, "largely unheeded by thousands of persons, periodontal disease, with little hue and cry, exacts a yearly toll

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in tooth loss which mounts into millions." Periodontal disease clearly represents a major health problem for virtually every American. Epidemiologic studies, to be discussed in some detail below, have demonstrated the world-wide prevalence of periodontal disease.[46]

II. ROLE OF DENTAL CALCULUS

It was considered axiomatic by the earliest dental "researchers" that calculus or tartar was associated with periodontal disease.[65] Recent studies have attempted to quantify this relationship and evaluate the significance of the correlation, by statistical, clinical and experimental laboratory methods.

A. *Epidemiologic Studies*

Field studies in humans have been undertaken to estimate the prevalence of periodontal disease and to relate the incidence and severity to oral hygiene factors (including dental calculus). The periodontal Index (Russell),[45] The Ramfjord Index,[41] and the PMA Index[49] have been generally used to measure periodontal disease. Calculus has been measured as part of the Oral Hygiene Index[13] and, more recently, by the Volpe-Manhold-Hazen method.[60] Other clinical measures of calculus also exist and this literature has been reviewed previously.[9]

In a typical study,[38] 123 subjects were selected from patients reporting for routine prophylaxis or periodontal therapy. A numerical index was established for periodontal disease and calculus (as well as other factors) and the degree of association between the factors was determined. In this study, a correlation coefficient of +.86 for periodontal scores and calculus was obtained. This was statistically significant at the 99 per cent level of confidence.

Similar results were reported by other investigators. Marshall-Day and coworkers reported a correlation between calculus deposits and periodontal disturbances.[30] A "strong association" between the percentage of teeth with calculus and all forms of periodontal disease has also been reported.[48] Calculus was found in 42 per cent of subjects with gingival recession.[11] In a study designed to evaluate the role of systemic diseases, a greater correlation was seen between calculus and gingivitis than between gingivitis and ascorbic acid (Vitamin C) levels.[15]

The U.S. National Health Survey found a close relationship between calculus and periodontal disease in a broadly representative sample of United States adults.[35] The authors concluded that faulty oral hygiene not only invites the onset of periodontal disease, but causes it. A higher correlation was seen between calculus and periodontal disease than between debris and periodontal disease. Although poor oral hygiene was ubiquitous in the cross-sectional sample, variations were seen in sex, race, and level of income and education. The authors further state that, "because of a slow, but steady accumulation of calculus, oral hygiene in both men and women became progressively worse with advancing age."

Periodontal disease is universal[46] and most studies have shown a close relationship between hard deposits on the teeth and either the incidence or severity of the disease. The association of calculus accumulation with increasing severity of periodontal disease has been demonstrated in Finland,[1] India,[42] Malta,[37] Chile,[4,44] and Paraguay.[32] In a summary of studies in five countries[43] (India, Ceylon, Nigeria, Iran and the Sudan), it was noted that the correlation between calculus and periodontal disease became higher in older age groups. In each country, an "overwhelmingly strong association" was found between the amount of debris and/or calculus and the severity of periodontal disease. Similar results were obtained in Canada,[58] Norway,[6] and in a combined study in Ecuador and Montana.[12] In this last study, a survey of 5,685 persons resulted in a significant correlation ($r = +.71$) between calculus and periodontal indices.

The same relationship has been demonstrated in populations with systemic disease. Gingivitis and periodontal pocket formation were associated with calculus in diabetics.[5] "A hard irritant index was statistically correlated with the gingival and periodontal scores" in a study of pregnant women.[7] The effect of these irritants was greater during pregnancy than *post partum*.

Most of the above studies have also demonstrated a positive relationship between soft deposits (debris, plaque, etc.) and periodontal disease. However, in Uganda, investigators

concluded that periodontal disease was "correlated to calculus formation rather than to plaque."[53] Other workers concluded that after age 20 in females and age 24 in males, only calculus affected the periodontal index.[21]

The epidemiologic studies reviewed above have shown that periodontal disease is universal, and that there is a definite relationship between deposits on the teeth and periodontal disease. This close statistical correlation obviously does not prove the etiologic role of calculus in the production of periodontal disease. A logical step would be to test this hypothesis in an animal model system. Such a model does not exist, but some studies have been done which are relevant to this review

B. *Opinions Stated in the Literature*

Over the past several years, numerous authorities have reviewed the studies concerning the etiology of periodontal disease and placed their opinions on record. In most cases, the authors surveyed the roles of calculus, debris, plaque and systemic factors prior to reaching a conclusion. Those writers who have expressed opinions on the positive relationship between calculus and periodontal disease will be cited.

Wah Leung[61] concluded that gingival deposits such as plaque and calculus constitute the most important etiologic agent for many periodontal diseases. He theorized that physical damage caused by calculus could lead to inflammation and bacterial invasion. Jenkins[14] also agreed that deposits on the teeth are a major factor in the causation of periodontal disease. He proposed that calculus acts as a mechanical irritant producing a periodontal pocket. Food debris and bacteria collect in this pocket resulting in bacterial invasion of the periodontal area and further tissue damage.

Schroeder,[50] in a recent monograph, stated that supra- or subgingival calculus is a direct cause, or principal component of the complex of causes, of periodontal disease. "A majority of the authors (as reviewed by Schroeder), state that dental calculus displaces the gums by its growth in an apical direction." He further suggests that the pathogenicity of sterile calculus is slight, but that bacterial plaque forms over the retentive surface of calculus.

Pelton[40] concluded that calculus is implicated clinically and epidemiologically as a factor in the production of periodontal disease. He further suggests that it is possible to alter a condition by altering an associated factor without knowledge of the direct causal factor. Thus, periodontal health might be improved by reducing calculus, even though it might not be a direct causal factor.

Salivary calculus was termed "one of the most vicious etiologic agents in parodontal diseases" by King and Martin.[16] They believed that the influence of oral microflora was secondary to irritation and traumatic injury of the gingival surface. A Workshop at the University of Michigan[59] concluded that "evidence indicates that dental calculus is an irritant which contributes to the ulceration of the crevicular epithelium and subsequent periodontal pathosis." Zander[66] noted that "gingival tissue that comes in contact with calculus is exposed to both bacteria and mechanical irritation." Theilade and Schroeder[57] summarized a review of recent (1966) results in dental calculus research with the statement: "The deposition of dental deposits is the most important cause of periodontal disease."

Löe has conducted studies in humans and found that oral deposits play a major role in the development and maintenance of periodontal disease.[23] He noted that calculus is always covered by an unmineralized bacterial deposit.[24]

Mandel also believes the role of calculus to be important. He has stated, "prevention of calculus formation is certainly an important goal for the dental profession."[27] More recently, he has noted that calculus may be an etiologic factor primarily because of its bacterial component.[28,29] The mineralized material serves to bring the bacterial plaque closer to the tissues, it interferes with the local self-cleansing mechanisms, and it makes plaque removal (oral hygiene) more difficult for the patient.

Waerhaug and his co-workers have taken a similar posture. He has stated that the main effort in prevention should be the removal of bacterial deposits.[63] Calculus, with its superficial layer of plaque, is related to gingivitis.[26] A strong correlation was again reported between the prevalence and severity of periodontal disease

and the accumulation of calculus and plaque.[64]

Recently, several periodontal researchers responded to the question: "What is the role of subgingival calculus in the etiology and progression of periodontal disease?"[31] Although each writer expressed an independent opinion, the consensus was that calculus is pathogenic and that the pathogencity is probably related to the toxic bacterial plaque and metabolic products on its surface. The physical structure itself may prevent proper oral hygiene as well as impede gingival circulation and irritate adjacent soft tissues.

C. *Studies in Humans*

Following the logical sequence developed in this review, the next step would be an examination of those human clinical studies which relate a reduction in calculus to an improvement in periodontal health. In other words, from the accepted epidemiologic evidence that calculus is an etiologic factor in periodontal disease and if the few animal studies are applicable to humans, then the theories of competent authorities should be evaluated in clinical studies. It should be expected that the reduction in calculus would result in better oral health.

Only a few such studies have been done. As Schwartz has stated,[51] "For years the dental profession has sought a means to simplify treatment of one of the primary local etiologic factors in periodontal disease, dental calculus."

Emslie surveyed studies in developing countries and concluded that a "dramatic improvement in the periodontal condition of a community can follow better oral hygiene."[8] Lobene[22] evaluated an automatic toothbrush and found a correlation coefficient of +.70 for reduction in calculus and gingivitis. Waerhaug[62] reported that complete removal of calculus resulted in a more or less complete disappearance of the inflammation caused by calculus.

Lovdal and his co-workers have reported a 5 year controlled oral hygiene program in 1,428 subjects.[25] Meticulous oral hygiene and scaling resulted in an average reduction in gingivitis to one-eighth in those with "good" hygiene, one-third in those with "fairly good" oral hygiene, and one-half in those with "not good" hygiene. Tooth loss in this group was estimated at "one-half normal."

For an institutionalized population, Suomi found that subjects who reported brushing twice or more per day had lower gingivitis, debris and calculus scores than those who brushed once or not at all.[55] Along with other workers, he also has shown that persons receiving frequent prophylaxes have cleaner teeth and less gingival inflammation.[56] Large increases in calculus scores were seen for subjects in groups without regular prophylaxes and oral hygiene. These same control groups had higher gingivitis scores. This three year study involved 1,248 non-institutionalized volunteers.

The relationship between smoking, calculus formation, and gingivitis was examined in 400 subjects by Alexander.[2] He found that in one group of patients, smokers had significantly more calculus and more extensive gingival inflammation than non-smokers. The prevalence and extent of plaque did not differ between the smokers and non-smokers. Alexander concluded that both calculus formation and gingivitis are increased by smoking.

The U.S. Air Force has been conducting a similar study at the U.S. Air Force Academy.[19,20,47] The study has documented the importance of the reduction of hard deposits on the teeth. Groups with the greatest reduction in hard deposit status had the greatest reduction in gingivitis scores. The authors found that "with frequent prophylaxis, the rate of calculus formation is not influenced by the amount of retained plaque."[20]

The consensus of other recent authors is that dental calculus has a pathogenic potential derived from the associated plaque.[18] Speirs has concisely stated that "bacterial plaque is the prime cause of the disease (chronic periodontitis). Calculus . . . merely favor(s) plaque formation or accelerate(s) its effects on the periodontium."[54]

In a recent study of human gingival biopsy material,[52] it was noted that calculus, in association with plaque, was more irritating to the gingiva than plaque alone. The reaction of tissue to several types of "tooth accumulated material" was greatest for bacterial plaque, in association with calculus. Pellicle and materia alba produced little or no inflammation.

III. CONCLUSIONS

From this review, it is apparent that calculus plays a significant role in the etiology and progression of periodontal disease. This role is probably mediated by combined chemical, bacterial, and mechanical irritation.

Calculus is important both as an entity in itself and as a locus for plaque accumulation. Plaque, adherent to calculus, is in close proximity to the gingival tissues. An effective calculus inhibiting agent might be expected to result in improved oral health by eliminating calculus as a local irritant and as a locus for additional plaque formation.

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North American Medical/Dental Conference

The 6th Annual North American Medical/Dental Conference (February 23–28) and Seminar (March 23–27) will be held at the Wildwood Inn at Snowmass in Aspen, Colorado. For further information contact: M. E. Schmidt, D.D.S., N.A.M./D.A., 1125 East 17th Street, E227, Santa Ana, California 92701. (714) 558-3256

Survey of Preventive Practice by Dental Hygienists 1974

Part I: Work Patterns According to Office Utilization and Procedures Performed

Lawrence A. Friedman, D.D.S.* and Christine I. French, R.D.H.**

In 1959, the National Opinion Research Center reported[4] the use of preventive measures in dental care. The data demonstrated that the utilization of a dental hygienist "is an important factor for preventive practice by dentists." The report included the role of the dental hygienist in preventive dentistry. Lately the dental profession has been involved in what has been termed "a preventive dentistry revolution."[1-3] Lectures and seminars in preventive dentistry, plaque control, and patient motivation have attracted great numbers of dentists and auxiliaries. Increased utilization of dental auxiliaries in preventive practice has provided new roles for the dental team, such as the control therapist. The control therapist is an expert in motivating patients to improve oral health by effective plaque control. There has also been a significant number of new plaque disclosants, toothbrushes, floss holders and threaders, and water irrigators. Each is designed to improve personal oral hygiene. What has been the impact of these changes in private practice, and to what extent have they been implemented?

In 1974 a preventive dentistry survey was conducted of the dental hygienists licensed and practicing in Texas. The aims of this survey were to: (1) compare the utilization of the dental hygienist in the preventive practice of dentistry in 1959 and 1974, (2) determine the present attitudes and behavior of practicing dental hygienists in the area of preventive dentistry, (3) determine what constitutes a preventive practice, and (4) evaluate the impact of the recent advances in preventive dentistry upon the profession of dental hygiene.

The results of this survey will be reported in two parts. This paper: (1) details the demographic character of the respondents of this survey, (2) compares the work patterns of dental hygienists in 1959 and 1974, and (3) establishes the change in proportion of time spent by dental hygienists in the performance of specific preventive procedures in 1974 as compared to 1959.

Another paper will present the attitudes of dental hygienists toward preventive dentistry, as well as what constitutes a preventive practice in those practices presently utilizing dental hygienists. Data will be presented concerning the use of control programs, the effective use of local and systemic preventive dental therapeutics, and the expansion of duties of dental hygienists.

MATERIALS AND METHODS

The questionnaire used for the 1974 survey consisted of 33 questions. All the questions except one were multiple choice. Several allowed for a fill-in answer when the choices were non-

This survey was sponsored by the Houston District Dental Hygienists' Society.

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Table 1. Proportionate Number of Years Licensed to Practice Dental Hygine (1974)

	Hygienists Responding (%)
Less than 1 yr	11
1–2 yrs	17
2–5 yrs	26
5–10 yrs	21
10–15 yrs	15
More than 15 yrs	10
Total	100
Number of Respondents	312

applicable. Space was allowed for comments by the respondents. The subject matter of the questionnaire was divided into four categories: (1) demographic, (2) preventive measures currently performed, (3) comparison of preventive measures performed in 1959 and 1974, and (4) attitudes concerning the practice of preventive dentistry. The questionnaire was pre-tested for comprehension and reliability.

Questionnaires were mailed to 900 dental hygienists licensed in Texas. The names and addresses were provided by the licensure records maintained by the Texas Dental Hygienists' Association and the Texas State Board of Dental Examiners. All questionnaires were mailed first class with return envelopes provided. The dental hygienists were asked to complete the questionnaire only if they were employed in the practice of dental hygiene at the time covered by the survey. Six weeks were allowed for the return of the questionnaire.

RESULTS

1. *Population:* 312 of the 900 questionnaires were returned and tabulated. Responses were randomly distributed according to the number of years licensed to practice dental hygiene (Table 1). The mean time since licensure was 6.1 years.

2. *Work Habits:* 78 per cent of the hygienists reported employment in one dental office, 18 per cent in two offices, and 4 per cent in more than two offices.

Tabulation of the days worked per week (Table 2) revealed that 39 per cent of the hygienists were currently employed more than four days per week, as compared to 51 per cent in this category in 1959. Fifty-five per cent of the hygienists presently reported working two to four days per week as compared to 35 per cent in 1959.

Table 2. Dental Hygienists' Reports of Time Spent in the Dental Office (1959 *vs* 1974)

Days and Hours Working	Proportion Reporting Each Amount of Time (in per cent)	
	1959	1974
Days Per Week		
Less than 2	12	6
2–4	35	55
More than 4	51	39
Not ascertained	2	—
Total	100	100
Hours Per Day		
Less than 7	8	6
7–8	73	76
More than 8	17	18
Not ascertained	2	—
Total	100	100
Hours Per Week		
Less than 16	19	6
16–34	30	53
34–44	41	37
More than 44	8	3
Not ascertained	2	—
Total	100	100
Number of Respondents	59	312

In 1959, 73 per cent of the hygienists reported that they worked 7–8 hours per day, compared to 76 per cent in 1974. In 1959, 30 per cent of the hygienists worked 16–34 hours per week, and 41 per cent worked 35–44 hours per week, as contrasted with 53 per cent and 37 per cent respectively in 1974 (Table 2).

Sixty-three per cent of the hygienists reported treating 9 to 12 patients per working day (Table 3), while 30 per cent of the hygienists treated 8 or less patients per working day. The remainder (7%) treated up to 19 patients per working day, with one treating 34 patients per working day. The overall average number of patients treated per working day was 10.1.

3. *Comparison of Preventive Measures:* The four services defined in the 1959 survey as preventive practice were oral prophylaxis, taking

Table 3. Number of Patients Seen Per Day by Hygienists (1974)

Number of Patients	Hygienists Responding (%)
Less than 8	30
9–12	63
13–16	7
More than 17	—
Total	100
Number of Respondents	312

X-rays, applying topical fluoride, and providing in-office patient education. Table 4 compares the performance of the specific preventive procedures by different office personnel.

Table 5 compares the 1959 and 1974 proportions of time spent by dental hygienists performing preventive procedures plus secretarial work, chairside assisting, and laboratory work. In both surveys, the majority of the dental hygienists' time was spent at oral prophylaxis (59% in 1959 and 48% in 1974). There was a significant increase in the percentage of hygienists who routinely perform additional patient education services. In 1959 only 2 per cent of the dental hygienists spent more than 25 per cent of their time in providing additional patient education, as compared to 33 per cent in 1974.

Dental hygienists presently spend more time taking X-rays as evidenced in Table 5. Thirteen per cent of the dental hygienists in 1959 spent at least 10 per cent of their time taking X-rays, as compared to 54 per cent in 1974. In 1959, 29 per cent of the dental hygienists did not take X-rays, as compared to 7 per cent in 1974.

The increased use of topical fluorides is proved by evidence that in 1974, 50 per cent of the dental hygienists spent at least 10 per cent of their day in the topical application of fluorides, as compared to only 3 per cent of the hygienists for the same period in 1959. In addition, 53 per cent of the dental hygienists did not use topical fluorides in 1959 as compared to 9 per cent in 1974. There was a decrease in the number of hours spent performing secretarial duties, chairside assisting and laboratory procedures in 1974 compared to 1959.

There is no appreciable change in the relative number of oral prophylaxes performed by dentists and dental hygienists in the two periods under comparison (Table 4). Dental hygienists performed all prophylaxes in approximately 50 per cent of the respondent's offices. This was similar in both surveys, (51% in 1959 *vs* 48% in 1974).

There was a significant increase in the use of auxiliary personnel for patient education (5% in 1959 *vs* 33% in 1974). This was also evidenced by a concurrent reduction in the number of offices in which patient education was re-

Table 4. Hygienists' Report of Persons Performing Various Preventive Measures (1959 *vs* 1974)

	Proportion of Dental Hygienists Reporting Each Person(s) as Those Performing Indicated Measure							
	Prophylaxis		Patient Education[a]		X-rays		Topical Fluoride Treatments	
Persons Performing Preventive Measure	1959	1974	1959	1974	1959	1974	1959	1974
Hygienists only	51%	48%	10%	23%	7%	8%	41%	58%
Hygienists and dentist	49%	52%	82%	33%	51%	29%	7%	31%
Hygienists, dentist and other office help			5%	33%	9%	34%		3%
Hygienists and other office help			3%	9%	3%	23%		3%
Dentists only					18%	1%	24%	1%
Dentists and other office help					9%	1%		
Other office help only				2%	3%	4%		
Not done at all							4%	28%
Total per cent	100%	100%	100%	100%	100%	100%	100%	100%
Number of Respondents	59	312	59	312	59	312	59	312

[a] Includes patient education given simultaneously with prophylaxis.

Table 5. Dental Hygienists' Report of Time Spent Per Week on Various Functions (Per Cent of Total Time Spent Per Week–1959 *vs* 1974)

Proportion of Time Spent Per Week at Functions (Of Total Time Spent As A Hygienist)	Proportion of Dental Hygienists Reporting Each Proportion of Time Spent at Performing Indicated Function																	
	Prophylaxis		Additional Patient Education[a]		X-rays		Topical Fluoride Treatments		Secretarial Work		Chairside Assisting		Laboratory Work	
	1959 *vs*	1974	1959 *vs*	1974	1959 *vs*	1974	1959 *vs*	1974	1959 *vs*	1974	1959 *vs*	1974	1959 *vs*	1974
None		1.0	42	0.9	29	7	53	9	51	19.0	71	64.0	89	79
Less than 5%			15	7.3	36	16	22	16	12	40.0	9	28.0		15
5–9%			15	13.5	20	23	10	25	7	17.0	3	3.0	5	3
10–14%		1.0	12	15.0	10	21	3	21	8	14.0	3	2.0	2	1
15–19% [b]	9	0.6	5	12.0		7		6	5	4.0	2	1.4		1
20–24% [b]		1.4	7	18.0	3	9		8	2	2.5	2	0.3	2	
25–49%	3	5.0		22.0		9		8	7	3.2	6	1.0		1
50–74%	25	43.0 [b]	2	11.0		6		4				0.3		
75% and over	59	48.0		0.3		2		3 [b]	3	0.3				
Performs, but amount of time not ascertained	4		2		2		12		5		4		2	
Total per cent	100	100.0	100	100.0	100	100	100	100	100	100.0	100	100.0	100	100
Number of Dental Hygienists	59	312.0	59	312.0	59	312	59	312	59	312.0	59	312.0	59	312

[a] Does not include patient education given simultaneously with prophylaxis
[b] Data available only for interval bracketed.

stricted to the dentist and/or to the dental hygienist (82% in 1959 *vs* 33% in 1974). Thirty-three per cent of the offices in the 1974 survey reported that patient education was provided only by auxiliary personnel, as compared to 13 per cent in 1959.

The proportion of offices in which only dental hygienists take X-rays remained constant (7% in 1959 *vs* 8% in 1974). The sharp decrease in the number of offices in which X-rays were taken either by the dentist or the dental hygienist (51% in 1959 *vs* 29% in 1974) was offset by the increase in the proportion of other members of the office staff taking X-rays (12% in 1959 compared to 57% in 1974).

There was a significant change in frequency of use of topical fluorides. In 1959, 28 per cent did not use topical fluorides, as compared to 4 per cent in 1974. In the current report, 61 per cent of the practices responded that topical fluoride was applied by personnel other than the dentist, compared to 41 per cent in 1959.

DISCUSSION

Significant differences have been found in the work load of the dental hygienist between 1959 and 1974. The practicing dental hygienist of today has approximately six years' experience. The probability of a dental hygienist being employed exclusively in one office is almost four to one. Better than 50 per cent of the dental hygienists are now working two to four days per week, compared to about 33 per cent in 1959. This is reflective of a shorter dental work week, and is reinforced by the reduction of hours worked per week, although the number of hours worked per day has increased slightly (Table 2).

Preventive dentistry has changed during the past 15 years as is clearly demonstrated in Tables 4 and 5. Table 4 reflects the delegation of preventive practices to auxiliary personnel. Except for prophylaxis, dental auxiliaries other than dental hygienists are now providing more of the preventive services described. A significantly greater number of offices are using topical fluoride treatments.

Table 5 further reflects the increased attention to preventive practice. Dental hygienists now are spending more time in the areas of

prophylaxis, patient education, X-rays, and topical fluoride application; and less time on secretarial duties, chairside assisting, and laboratory work. Dental hygienists are also performing duties today that were not performed in 1959: *i.e.*, polishing amalgams, placement of temporary restorations, desensitization, myofunctional therapy, nutrition counseling, removal of sutures, and placement of sealants. This reflects the increased responsibility of the dental hygienist in the practice of dentistry.

This survey indicates that preventive dentistry has brought about two major changes in dental office management, notably an increased utilization of all auxiliary personnel, and an increased responsibility of the dental hygienist in the practice of preventive dentistry. These findings suggest that more preventive dentistry is being practiced and that a greater percentage of dental patients are accepting and receiving preventive services.

SUMMARY

Nine-hundred questionnaires were sent out to dental hygienists practicing in Texas. Three hundred-twelve were returned for tabulation. The mean time in practice of the respondents was 6.1 years. There was a reduction in working days and hours per week, but an increase in hours per day for dental hygienists practicing in 1974 compared to 1959. The average number of patients treated daily by a dental hygienist is 10.1.

Dental hygienists have greatly expanded their role in dental practice. This expansion is primarily in the areas of patient education, taking X-rays, and the application of topical fluoride. They are spending more time in the dental office in the practice of preventive dentistry and less time performing secretarial and laboratory duties. Dental hygienists are performing services in 1974 that they did not perform in 1959 due to the expanded duties of the dental hygienist.

Other dental auxiliaries (dental assistants, control therapists) are assisting in the practice of preventive dentistry particularly in the areas of patient education, taking X-rays, and the application of topical fluorides. Greater emphasis is being placed on preventive dentistry in 1974 than was the practice in 1959.

ACKNOWLEDGMENT

The authors respectly appreciate the cooperation of Jan Davis, R.D.H., Mary Jo Foster, R.D.H., and Samuel Dreizen, D.D.S., M.D. in the design, implementation, and evalution of this survey.

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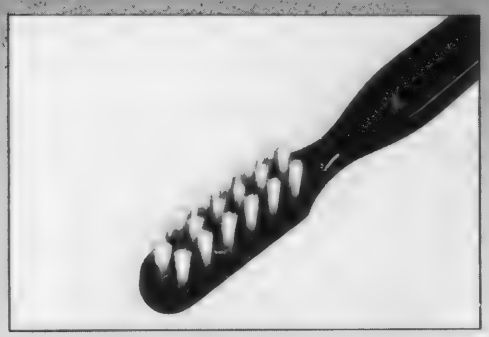

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Characteristics of Dental Oral Hygiene Education in Private Practice*

Helen Gift, Ph.D.,** Tommy Muller, M.S., and John Newman, Ph.D.

Preliminary studies of oral hygiene education have indicated a wide range of definitions and attitudes toward the value of educating the dental patient in oral hygiene, as well as a wide variety of approaches for accomplishing this task.[1-13]

This study reports on 1) an investigation of practicing dentists regarding their attitudes toward oral hygiene education as a preventive measure, and 2) a discussion of the types of oral hygiene education currently in use in the private practice dental office.

METHODOLOGY

A mailed survey was developed to obtain an overview of general preventive attitudes, and to determine the utilization of preventive measures. To further clarify the operation of oral hygiene education, a follow-up interview of respondents (50) was done. This follow-up interview was designed to specify the nature of oral hygiene education in those offices where it was used. The sample who participated in the questionnaire and the follow-up interview consisted of Illinois dentists, under 65 years of age, randomly drawn from two strata: those practicing in Chicago and those practicing outside of the metropolitan area. The response rate to the mailed questionnaire was 62 per cent (N = 73).

The results describing and interpreting oral hygiene education programs are based on two instruments. The mailed survey provides both general and comparative information on oral hygiene education as a preventive measure; the follow-up interview provides more in-depth information from a subsample of this group of dentists regarding the nature of oral hygiene education in the office.

Major variables included the type of oral hygiene education measures used in the oral hygiene instruction, criteria for evaluating the success of the instruction, the attitude toward parental involvement in education, and the use of preventive recall. Additional variables included type of practice, number of children seen, use of auxiliaries, use of other preventive measures (fluorides, *etc.*), and general attitude toward preventive measures.

Table 1. Number of Assistants by Delegation of Oral Hygiene Education*

Full-time Dental Assistants	Staff Responsible for Oral Hygiene Education				
	Dentist	Hygienist	Assist.	Combination	Total
0	9 (53%)	4 (23%)	2 (12%)	2 (12%)	17
1	4 (19%)	11 (53%)	3 (14%)	3 (14%)	21
2 or more	1 (4%)	9 (33%)	13 (48%)	4 (15%)	27
Total	14	24	18	9	65

P ($X^2 \geq 2.12$) ≤ .001
Lambda: .263
Cramer's V = .404

* No answers are excluded from this and subsequent tables. Based on the questionnaires, N = 73.

From the Division of Behavioral Sciences, Research Institute, American Dental Association Health Foundation, Chicago, Illinois.

* This is a revision of a paper presented at the 52nd General Session of the International Association of Dental Research, 1974. This investigation was supported by Contract N01-DE-32423 from the National Institute of Dental Research.

** Chief, Division of Behavioral Sciences, Research Institute, American Dental Association Health Foundation, 211 East Chicago Avenue, Suite 1748, Chicago, Illinois 60611.

Table 2. Auxiliary Responsibilities in Oral Hygiene Education*

	Not Done	Dentist Only	Auxiliary Only	Combination of Dentist/ Auxiliary
General Oral Hygiene Instruction	15%	12%	58%	14%
Brushing Instruction	—	17%	63%	19%
Flossing Instruction	9%	15%	59%	13%
Disclosing Dyes	15%	12%	57%	13%

* Follow-up interviews (N = 17).

RESULTS

The following results describe the overall distribution of major variables based on the questionnaire and interview responses.

Over 50 per cent of the dentists in the mailed survey were in independent private practices, while the remainder were in some form of corporate or group private practice. Children under 13 constituted a small proportion of most practices. The mean per cent of patients under 13 was 23 per cent.

A. *Utilization of Oral Hygiene Education*

Table 1 illustrates the relationship between the use of dental assistants and the delegation of responsibility for oral hygiene education. With an increased number of assistants, the dentist performs oral hygiene education less frequently, the responsibility being delegated more often to the assistants.

The responsibilities of auxiliaries in oral hygiene education, as described in follow-up interviews, are shown in Table 2. The data demonstrates a high use of auxiliaries for these activities. Other measures were specified in the interviews as being part of oral hygiene education: audio-visual aids, counseling on diet and nutrition, instruction on the use of perio-aids, the use of chemical tests, and the use of microscopes.

Regarding brushing instruction, dentists on the questionnaire indicated that a variety of brushing techniques are being recommended, but that the "Bass" method is the most prevalent (23%). A majority of dentists are also giving instruction in brushing for problem areas (70%) and tongue brushing (60%).

In the follow-up interviews of the dentists, it was found that 29 per cent of the dentists utilized structured multi-visit or formal plaque control programs; another 16 per cent devoted one complete visit to oral health education, and considered it a formal program; and 38 per cent administered oral hygiene education as needed in an unstructured fashion. The use of formal or multiple-visit programs solely for oral hygiene education is restricted by use of auxiliaries. Many dentists give complete descriptions of oral hygiene procedures in their offices, but the complexity is not as great when there are no or few auxiliaries to handle the education and general procedures. Table 3 indicates the relationship between the use of assistants and the type of oral hygiene education program. The cell size restricts interpretation, but the use of assistants is greater in structured programs.

B. *Value of Oral Hygiene Education*

One aspect of oral hygiene education that is frequently discussed is its effectiveness as a preventive measure. The response pattern to the question regarding the per cent of patients who significantly alter their habits following oral hygiene education indicates the sample's evaluation of oral hygiene education. The mean per cent was 32, but the most frequent response was zero.

Another dimension of assessing the worth of oral hygiene education is the dentist's method of measuring *his* perceived level of success. Table 4 illustrates the most frequently mentioned criteria used to meas-

Table 3. Number of Assistants by Type of Oral Hygiene Education

Full-time Assistants	Structured			Total
	Multiple	One Visit	Varies	
0	2 (28.6%)	2 (28.6%)	3 (42.9%)	7
1	1 (7.7%)	2 (15.4%)	10 (76.9%)	13
2 or more	11 (52.4%)	4 (19.0%)	6 (28.6%)	21
Total	14	8	19	41

$P (X^2 \geq 9.3) \leq .05$
Cramer's V = .336

Table 4. Criteria of Success*

Clinical Observation	82%
Bleeding Gums	59%
Disclosing Dyes	51%
Patient Description	17%
Rate of Decay	14%
Appearance of Tissue	14%

* Per cent of sample mentioning criteria (dentist could mention up to three criteria). Follow-up interviews, N = 47.

ure the outcome of oral hygiene habits of the patient. Given the open-ended nature of the question, there is some overlap in the categories of responses, but it is evident that general observations of teeth, tissues and gums are the most commonly used methods. Patient participation methods, with the exception of disclosing dyes, are less frequently used.

The frustrations of oral hygiene education reflected in the amount of time spent on the education, the lack of "success" after spending this time, and the perceived unwillingness of patients to pay for oral hygiene education were also demonstrated along another dimension. It became clear that a major aspect of using oral hygiene education might be the ability to generate income from the time spent.

Tables 5 and 6 demonstrate this relationship based on questions asked on the mailed survey: 1) the per cent of income generated from preventive dentistry, and 2) a judgment on whether or not income from preventive dentistry was commensurate with the time spent. In both cases, greater perceived income from oral hygiene education is related to higher utilization of oral hygiene education.

Another problem of oral hygiene education is motivating

Table 5. Oral Hygiene Education and Preventive Dentistry Income by Age of Child*

% Income from Preventive Dentistry	Oral Hygiene Education (Under 13) All	Most/ Some	Total	Oral Hygiene Education (14 to 18) All	Most/ Some	Total
20% or more	8 (88.9%)	1 (11.1%)	9	9 (100%)	0	9
10–19%	10 (83.3%)	2 (16.7%)	12	9 (75.0%)	3 (25.0%)	12
5–9%	7 (46.7%)	8 (53.3%)	15	5 (25.7%)	9 (64.3%)	14
Less than 5%	10 (50.0%)	15 (60.0%)	25	10 (40.0%)	15 (60.0%)	25
Total	35	26	61	33	27	60

P ($X^2 \geq 10.8$) ≤ .01 Cramer's V = .420

P ($X^2 \geq 3.17$) ≤ .01 Cramer's V = .477

* Based on questionnaire responses.

patients to practice oral hygiene habits at home. For children particularly, this becomes an issue of involving the rest of the family (the parents) in the support of the newly learned skills.

There is agreement among dentists that it is helpful for the parents to be educated in the same procedures if the care is to be appropriately administered at home (68% agreed on the questionnaire that the best way of reaching children is to educate the parents). However, the interviews indicated a difference of opinion as to how this education should be handled: simultaneously or separately.

C. *Comparative Value of Oral Hygiene Education*

The overall value of oral hygiene education can best be seen by considering the importance given it in comparison to other preventive measures.

On the mailed survey, 72 per cent of the dentists agree with the statement that it is possible to prevent the formation of carious lesions given available techniques; 78 per cent think that it is the role of the den-

Table 6. Income Commensurate with Time and Oral Hygiene Education by Age of Child*

Income	Oral Hygiene Education (under 13) All	Most/ Some	Total	Oral Hygiene Education (14 to 18) All	Most/ Some	Total
yes	20 (76.9%)	6 (23.1%)	26	19 (76.0%)	6 (24.0%)	25
no	18 (47.7%)	20 (52.6%)	38	17 (44.7%)	21 (55.3%)	38
Total	38	26	64	36	27	63

P ($X^2 \geq 4.4$) ≤ .04

P ($X^2 \geq 4.8$) ≤ .02

* Based on questionnaire responses.

Table 7. Use of Preventive Measures on Most Children Under 13*

	Yes
Topical Fluoride	89%
Pit and Fissure Sealants	30%
Oral Hygiene Education	90%
Dietary and Nutritional Counseling	79%

Mailed Survey (N = 73)
* Based on questionnaire responses.

tist to devote time to preventive dentistry for children; and 89 per cent indicate that the practice of preventive dentistry is professionally rewarding. Table 7 indicates the utilization of various measures for preventive purposes. A high utilization of both oral hygiene education and topical fluoride for children under 13 is apparent.

The dentists in the mailed survey were asked to rank a list of preventive procedures in terms of their value in preventing caries in child patients. The five measures which received the largest per cent response of "great value" were: 1) preventive and restorative recall systems (85%), 2) fluoridated water (82%), 3) restoration of active carious lesions (82%), 4) oral hygiene education (80%), and 5) dietary and nutritional counseling (74%).

On the follow-up interview the dentists were asked to rank (open-ended question) the procedures that were of most value in preventing carious lesions. In these responses, oral hygiene education (43%) and fluoridated water (34%) received the most frequent first rank; fluoridated water (26%), oral hygiene education (21%) and dietary and nutritional counseling (21%) received the most frequent second rank. When queried on the reasons for the ranking, the dentists emphasized that oral hygiene education was the most important preventive measure, but that it was not generally as effective as fluoridated water and other fluoride measures because of the inability to get persons into the office for appropriate education and because of the problems associated with motivation for care of the teeth at home.

SUMMARY

The results seem to indicate that dentists strongly support the use of preventive dental measures and are firm advocates of the use of oral hygiene education. Also, the results indicate that the dentists feel a *combination* of preventive techniques are best at this time, even though oral hygiene education is probably the most important. Using a combination of procedures and methods, the dentist and the community are better able to reach more persons for prevention, even those who are poorly motivated to visit the dentist or those who are poorly motivated to follow through on the recommendations once they do visit the dentist's office.

The methodologies used were very beneficial in interpreting the nature of oral hygiene education. The data from the interview situation were most useful in interpreting the meaning of responses given on the mailed survey. The interviews also demonstrated the advantages of open-ended response questions for areas of study which are vague in definition (such as oral hygiene education).

Both the mailed questionnaire and the follow-up interviews were beneficial in preparing more valid questions for a revision of the mailed questionnaire for use on a national survey.

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Fischman, S, Cancro, L, Pader, M, Picozzi, A: Relationship of Dental Calculus and Periodontal Disease: A Review of the Literature. J Prev Dent **2** (January-February) 1975.

Abstract: The clinical evaluation of oral hygiene aids requires an understanding of the relationship between the several etiologic factors in periodontal disease. The literature concerning the etiologic role of dental calculus is reviewed with respect to epidemiologic studies, and human clinical studies. The authors conclude that calculus does play a significant role in the etiology and progression of periodontal disease. Calculus is important as an entity in itself and as a locus for plaque accumulation.

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Bernick, SM, Eisenberg, E: Anomalies, Stains and Discolorations of the Teeth. J Prev Dent 2 (January-February) 1975.

Abstract: Shade differences in tooth coloration are infinite, since the color of teeth is determined by enamel translucency which imparts various outward hues such as green, pink or blue superimposed on the yellow or brownish color of the deeper layers of dentine. The causes of tooth discoloration are manifold and the origin of these changes may be endogenous or exogenous. Often, pre-eruption structural changes and thickness changes of the dental hard tissues will leave the resulting tooth with an appearance which noticeably differs from the norm; penetration of the dentine or enamel (or both) by coloring agents after the formation of these hard tissues, in the presence or absence of structural changes, or the incorporation

Friedman, LA, French, CI: Survey of Preventive Practice by Dental Hygienists 1974 Part I: Work Patterns According to Office Utilization and Procedures Performed. J Prev Dent 2 (January-February) 1975.

Abstract: In 1974, a survey was conducted of dental hygienists licensed and practicing in the state of Texas. This paper reports that part of the survey which deals with the dental hygienists' demographic character, their work patterns, and the proportion of time they spend in the performance of specific preventive procedures. The work patterns and proportion of time spent in the performance of specific preventive procedures are compared to the results of a 1959 survey conducted by the National Opinion Research Center.

The results indicate that greater emphasis is being placed on preventive dentistry in 1974. Dental hygienists have expanded their role in dental practice, primarily in

Dolan, MM, Harding, ET, Yankell, SL: Effect of Rinsing Time on Antiglycolytic Properties of Amine Fluoride Mouthrinses. J Prev Dent 2 (January-February) 1975.

Abstract: In a clinical study on ten volunteers, an amine fluoride mouthrinse containing a 1:1 ratio of hetaflur and dectaflur inhibited salivary glycolysis for at least 90 minutes. *In vitro* studies indicate that each component acts by a different mechanism. Therefore, each was tested separately after either 10 or 30 seconds rinsing time. After 30 seconds rinsing time, the combination and each component gave similar results but, after 10 seconds rinsing time, the combination was superior to either component alone in inhibiting salivary glycolysis.

Gift, H, Muller, T, Newman, J: Characteristics of Dental Oral Hygiene Education in Private Practice. J Prev Dent 2 (January-February) 1975.

Abstract: This study reports practicing dentists attitudes toward and current usage of oral hygiene education as a preventive measure. A survey was mailed to a sample of Illinois dentists (62% response) with a follow-up interview of 50 of them. Half the dentists were alone in private practice, the remainder being in corporate or group practices. Mean per cent of patients under 13 was 23 percent. Dentists less frequently perform oral hygiene education themselves as the number of assistants increases. Structured or formal programs (29%) and informal programs (38%) are offered to patients. Oral hygiene education consisted of audio-visual aids, counseling on diet and nutrition, instruction on perio-aids, use of chemical tests and microscopes, and a variety of brushing techniques, "Bass" being the most prevelant

the areas of patient education, taking X-rays, and fluoride application. They are spending more time in the practice of preventive dentistry and less time performing secretarial and laboratory duties. In addition, the dental hygienists are performing services in 1974 that they did not perform in 1959 because of the legal expansion of duties. Other auxiliaries are assisting in the practice of preventive dentistry, particularly in the areas of patient education, taking X-rays, and fluoride application. There was a reduction in the dental hygienist's working days and hours per week, but an increase in the hours worked per day.

of coloring agents into the dental hard tissues during formation with accompanying structural changes will impart similar damage to the appearance and often, the function of the tooth during and after eruption. Post-eruption discolorations occur when discoloring agents enter the dental hard tissues through the pulp or enamel organ or when an agent of discoloration penetrates the enamel or dentine from the oral cavity or is superficially associated with these structures *via* this route.

(23%). Most frequently, dentists did not find patients significantly altering habits. General observations on teeth, tissues and gums were most often used as criteria of success. Greater perceived income from oral hygiene education is related to higher utilization. Dentists agreed that parents should be educated, but there were differences as to how to do it. Dentists felt caries could be prevented with available techniques and found preventive dentistry professionally rewarding. Oral hygiene was found to be the most effective preventive measure, but was generally less effective than fluoridated water and other fluoride measures.

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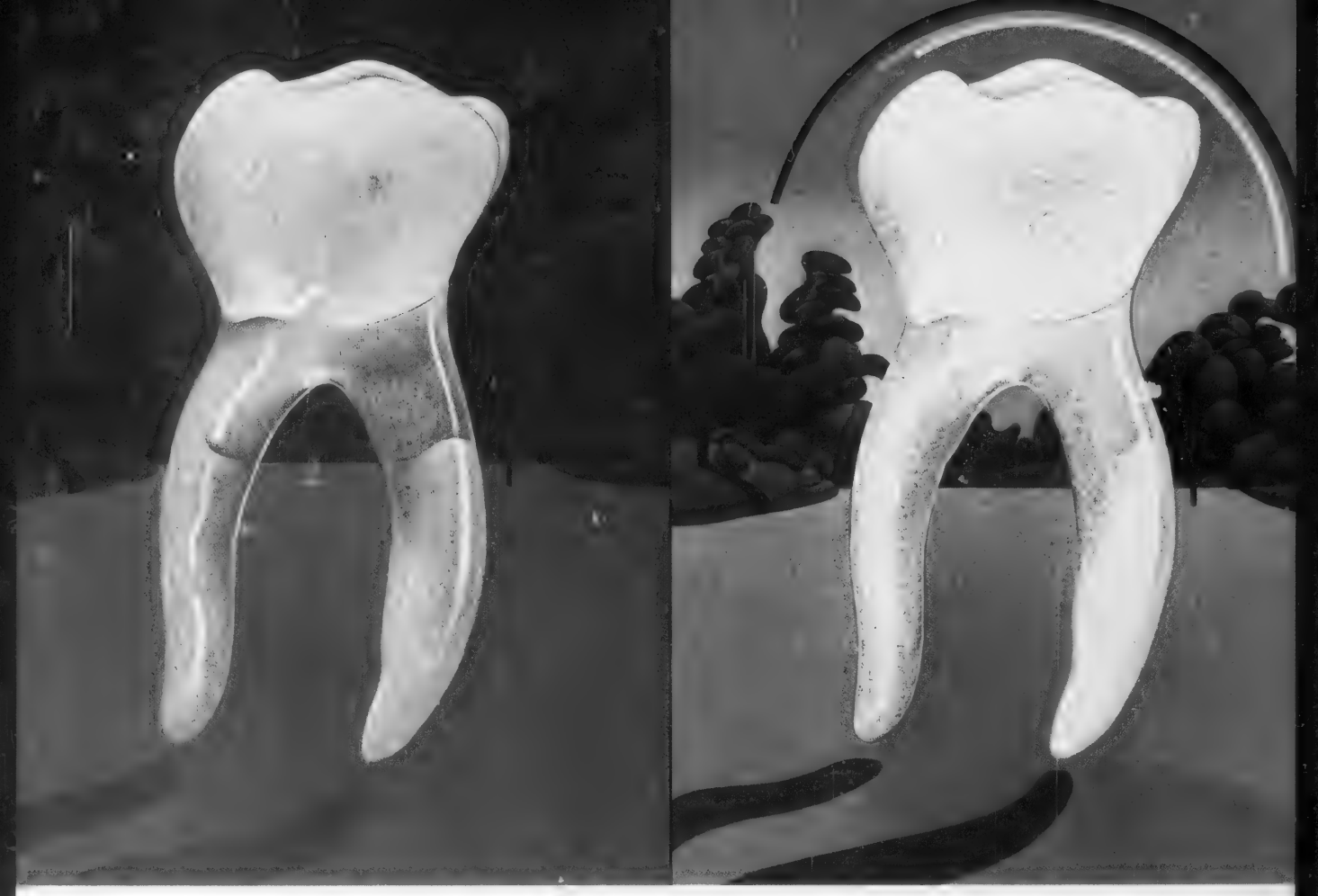

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☐ A Comparison of Microbial Plaque Disclosants After Personal Oral Hygiene Instruction and Prophylaxis ☐ Survey of Preventive Practice by Dental Hygienists 1974: Part II ☐ Nutritional Deficiencies: A Laboratory Mystery? ☐ The Effect of Dextranase on Oral Health in Children ☐ Oral Hygiene in Children: Relationship to Age and Brushing Time ☐ Brush-In 74

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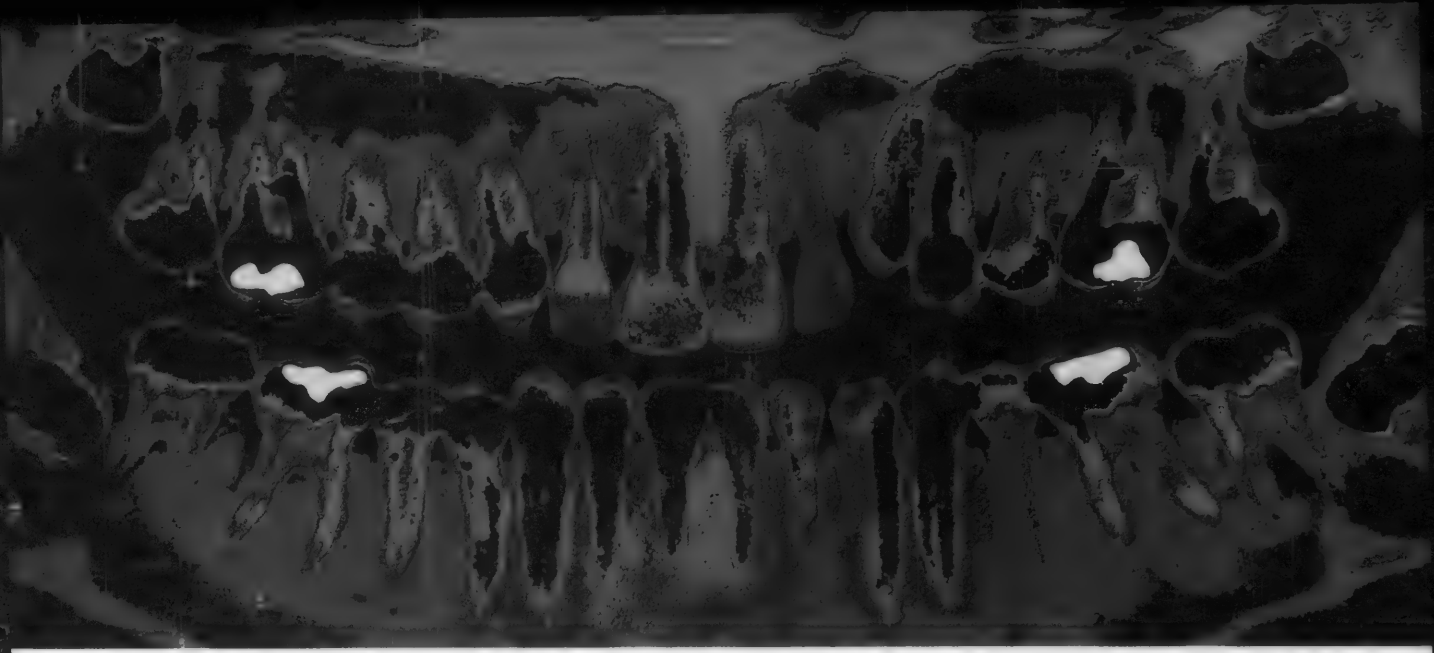

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[1]Horowitz, H., *et al.*, The Current Status of Topical Fluorides in Preventive Dentistry, *Fluorides and Dental Caries*, 34-59, 1972. [2]Aasenden, *et al.*, Effects of Daily Rinsing and Ingestion of Fluoride Solutions Upon Dental Caries and Enamel Fluoride, *Arch. Oral Biol. 17:* 1705-1714, 1972. [3]Frankl, S. N., *et al.*, The Topical Anticariogenic Effect of Daily Rinsing with an Acidulated Fluoride Phosphate Solution, *JADA 85:* 1972. [4]*The Federal Register: 39,* No. 94, May 14, 1974.

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A Comparison of Microbial Plaque Disclosants After Personal Oral Hygiene Instruction and Prophylaxis

Richard C. Squillaro, D.D.S., D. Walter Cohen, D.D.S.* and Larry Laster, Ph.D.

For some time, the accumulation of microbial plaque has been recognized as significant in the etiology of periodontal disease and has continued to be of concern to both researchers and clinicians. It is this concern which has resulted in an increased number of research projects on the subject and in greater attention in dental practices to educating patients about plaque control methods.

Traditionally, plaque control regimens performed at home in conjunction with periodontal therapy displayed a common weakness: the patient's inability to see distinct results of his or her efforts to remove plaque mechanically. Such a lack of feedback frustrated even those patients who were sufficiently motivated to seek therapy by an awareness of their disease.

Dental disclosing agents offer a correction of this weakness. With the use of a disclosant, the patient has some degree of feedback. No longer does he have to rely entirely on the therapist for an evaluation of his progress in plaque control.

The use of disclosants is not new. Skinner[12] and Raybin[9] were among the first to view them as potential adjuncts to the patient's normal oral hygiene practices. For them, disclosants provided visible evidence that esthetic cleanliness is an insufficient indication of good oral health.

Reprints may be obtained by writing to Dr. Richard C. Squillaro, Dept. of Periodontics, Univ. of Pennsylvania School of Dental Medicine, 4001 Spruce St., Philadelphia, Pa.

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Arnim[1] ultimately established the use of disclosing agents as an effective means of motivating patients to assume part of the responsibility for plaque control. As he noted, plaque forms far too quickly for the practitioner to control its accumulation.

Numerous disclosing formulations are available for use in research and in therapy; however, the overall effectiveness of a disclosant is important when it is considered for use at home by the patient. Possible criteria for evaluating the effectiveness of a disclosant, mentioned by Edwards[4], are: (1) It should be specific, *i.e.* it should stain microbial plaque rather than adjacent material such as calculus and pellicle; (2) It should stain plaque distinctly to provide a contrast with the gingiva; (3) It should be nonpathogenic and nonantibacterial; (4). It should be convenient to use; (5). It should be esthetically pleasant to use.

Arnim[2] recommended the use of an erythrosin dye (F.D. & C. Red No. 3) over that of merbromin, neutral red, and fuchsin tablets. He considered fuchsin particularly unsatisfactory due to its suspected carcinogenic property. Despite the advantages which Arnim noted, however, erythrosin presents the patient and the therapist with distinct disadvantages.

Erythrosin has been shown to be nonspecific. Among others, Lang and Löe[7] noted that the dye stains pellicle and oral mucosa, as well as plaque. Also, because the dye penetration is relatively nonselective, dye-stained plaque and the gingiva are difficult to distinguish.

Disclosure with erythrosin remains one of the simpler and more convenient adjuncts of home plaque control, particularly since the dye is available commercially in tablet form. However,

the prolonged and intense stains produced by the dye are almost universally viewed as unpleasant.

In view of erythrosin's clinical limitations, alternative disclosing methods have been actively sought. One of the more promising is the fluorescent disclosing solution. Hefferren,[5] surveying a number of dye penetration methods, notes the advantages of a fluorescing dye.

The characteristics of a fluorescing solution do appear to meet the criteria for an ideal disclosant. One which has been studied recently is a formulation of 0.75% fluorescein sodium in glycerin.[3]

As Lang and Löe[7] observed, fluorescein is specific; only plaque on the teeth, tongue, and oral mucosa fluoresces. Also, because of fluorescein's specificity, plaque on tooth surfaces and on the gingiva are clearly distinguishable. This is especially important since the patient who cannot distinguish the two may injure the gingiva by excessive brushing, a common problem among users of nonspecific disclosants.

Since plaque stained with a fluorescent solution is essentially invisible without an excitation light source, the use of this type of system offers several additional advantages. First, it is not esthetically objectionable to the patient, even under exposure to the light source.

The use of such a fluorescent system is both simple and convenient. Although Hefferren[5] observed that plaque is disclosed quite dramatically under ultraviolet excitation, it is possible to achieve excellent disclosure without an ultraviolet light source. In addition, various members of a family can use the same light source in identifying the stained plaque.

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PURPOSE

The purpose of this study was to compare the ability of two disclosing solutions to maintain and preserve the oral health attained after individual oral hygiene instruction and complete dental prophylaxis are administered by dental hygiene students in a clinical practice environment. The groups using test agents were also compared to a control group who used no disclosant.

MATERIALS AND METHODS

The study population consisted of 45 patients from the Oral Hygiene Clinic at the University of Pennsylvania, School of Dental Medicine. Each patient had at least 10 natural teeth per arch and had developed either gingivitis or incipient periodontitis.

Two disclosing solutions were used in this study: a specially prepared solution of 4 per cent F.D. & C. Red No. 3 (erythrosin dye), and the PLAK-LITE® solution containing 0.75 per cent D. & C. Yellow No. 8 (fluorescein sodium).

The subjects were randomly divided into three groups of 15 members each. The severity of the disease states was equalized in all groups. Group I was the control. Groups II and III were assigned the erythrosin and fluorescein solutions respectively.

Treatment was performed by five senior dental hygiene students. Each student treated 9 patients. The treatment consisted of scaling, root planing, polishing, and individual oral hygiene instructions which included the use of the modified Bass technique of toothbrushing.

The patients were scored at three intervals: first, at the initial visit when they were evaluated and assigned to study groups; second, at the completion of treatment; and finally two months after that treatment had been completed.

The scoring method used was a Gingival-Periodontal Index (GPI) as described by O'Leary.[8] The gingival status, the periodontal status, and the local irritants in each segment were evaluated.

The highest score for any one tooth in a segment was recorded as the score for that segment. After the highest score for each segment was recorded, the scores were added and the sum divided by the number of segments to give the Irritant Index for the entire oral apparatus. The scoring criteria were as follows: **Gingival: 0**-The gingival tissue was tightly adapted to the teeth and of firm consistency with a physiologic architecture; **1**-Slight to moderate inflammatory changes present involving one or more teeth in the segment, but not completely surrounding any

one tooth; **2**-If the inflammatory changes are found completely encircling one or more teeth in a segment; **3**-If marked inflammatory or gingival contour changes are present. **Periodontal:** The mesial-facial line angle of every tooth of each segment was probed with a Michigan probe noting the CEJ and directed along the long axis of the tooth and advanced to the depth of the pocket. **0**-If the probe does not extend 1 mm apical to the CEJ of *any* tooth in the segment and there is no exposure of the CEJ on any surface of any tooth in the segment; **4**-If the probe extends up to 3 mm apical to the CEJ of *any* tooth in the segment; **5**-If the probe extends from 3–6 mm apical to the CEJ of *any* tooth in the segment; **6**-The highest score for any segment.

The highest score (either gingival or periodontal) found for each segment is recorded and the sum divided by the number of segments to give the GPI score for the individual.

IRRITANT INDEX

The surfaces of each tooth were tested with the lateral aspect of the terminal ¼ inch of an explorer for plaque, supra and subgingival calculus, and overhanging or deficient restorations. **0**-When no detectable plaque or calculus is found on any tooth in the segment; **1**-If a slight amount of plaque or supragingival calculus covers up to ⅓ the exposed clinical crown on any tooth in the segment; **2**-If plaque and supragingival calculus covers ⅓ to ½ the clinical crown or if there are isolated areas or flecks of subgingival calculus; **3**-If plaque or supragingival calculus covers more than ½ of the clinical crown or if subgingival calculus or overhanging or deficient restorations are detectable by probing.

Three disease types were established at the initial examination—incipient, mild, and moderate. When the treatment phase had been completed and the disease state was essentially nonexistent, the dental examiner again scored the patients using O'Leary's indices.

Subjects in Groups II and III were then given directions concerning the use of the disclosant assigned. Subjects in Group III were also shown how to use the disclosing light in conjunction with the fluorescein solution. No disclosants had been used during the treatment phase. In this double-blind study, the scorer at no time knew the disclosant assigned to each of the patients.

Two months later, the patients were again scored according to O'Leary's indices.

RESULTS

The experimental design consisted of a two-way analysis of variance in randomized blocks where three severity blocks were formed on the 45 subjects' initial periodontal index scores (O'Leary's) prior to their assignment to both the treatments (3) and the various hygienists (5) within blocks at random. The dependent variable of measurement (Y_{ijk}) was formed by taking the difference between final scores (exam three) and interim scores (exam two), thus measuring the inhibitory effects of the various treatments on controlling disease after prophylaxis.

Mathematical Model:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \rho_k + (\alpha\beta)_{ij} + e_{ijk}$$

where i = 1 . . . 5 the hygienists, j = 1,2,3 the treatments, k = 1,2,3 the replication (blocks).

The orders in which the 9 patients were seen by each hygienist were also randomized to neutralize the effects of practice as the hygienists became possibly more proficient. These univariate analyses were performed for each of the 6 dependent variables (GI, GPI, PI, PLI, II, HDI) and then followed by both univariate and multivariate simultaneous confidence intervals to detect the possible sources of significance.

In each of the 6 indices a progressive (see Table 1) decrease (for E_3-E_2) in disease was exhibited from control to erythrosin to fluorescein when summing across the 5 hygienists' effects. An interaction of treatments with that of hygienists was not detected in all but one index where marginal significance was demonstrated (i.e. GI at $P = 0.05$). For the most part, additivity of the treatment effects across the hygienists was a reasonable assumption. Significant differences among the five hygienists were not present for any of the six disease indices. Statistically significant main effects were demonstrated, however, for both the GI ($F_{2;27} = 21.93$, $P < 0.001$) and PLI ($F_{2;27} = 19.36$, $P < 0.001$) indices. Scheffé-type[11] univariate multiple com-

Table 1

	Group I				Group II				Group III			
	E_1	E_2	E_3	$E_3 - E_2$	E_1	E_2	E_3	$E_3 - E_2$	E_1	E_2	E_3	$E_3 - E_2$
GI	2.34	.49	1.90	1.41	2.57	.45	1.65	1.20	1.87	.28	.60	.32**
GPI*	3.33	2.33	3.12	.79	3.53	2.54	3.19	.65	3.36	2.54	2.79	.25
PI	2.74	2.29	2.73	.44	2.87	2.46	2.81	.35	3.03	2.52	2.61	.09
PLI	1.82	.41	1.52	1.11	1.96	.28	1.26	.98	1.77	.18	.40	.22**
II	1.86	.41	1.52	1.11	1.96	.35	1.26	.91	1.77	.22	.44	.22
HDI	1.27	.07	.41	.34	1.15	.10	.38	.28	.90	.05	.15	.10

* Blocking variable.
** $P < .001$ univariately.

parisons with $1\text{-}\alpha = .99$ were then generated for both the GI and PLI indices separately (see Table 2) where in each case the fluorescein group was significantly different from that of the control and the erythrosin groups, while *no* difference was detected between the latter two.

At this point, multivariate simultaneous comparisons were considered to present a joint probability statement for group differences with all 6 indices taken simultaneously into account. The Roy and Bose[10] procedures for joint confidence statements were based upon only 5 of the original 6 disease variables due to a 2 index linear dependence (PLI = II) found to exist within the data.* Treatment group significance patterns noted in the univariate comparison were also found to be present in the multivariate sequel (see Table 3) with both the GI and PLI producing these contrasts with $1\text{-}\alpha = .95$ jointly (for fluorescein < erythrosin = control).

* PLI was used.

Table 2. Scheffé type Multiple Comparison for GI and PLI Indicies with $1 - \alpha = .99$

GI (Pairwise)
$-.3615 \leq \mu_C \gtrless \mu_E \leq .7815$
$.3085 \leq \mu_E - \mu_F \leq 1.4515$ (zero excluded)

PLI (Pairwise)
$-.3729 \leq \mu_C - \mu_E \leq .6329$
$.2571 \leq \mu_E - \mu_F \leq 1.2629$ (zero excluded)

Table 3. Simultaneous Multivariate Comparisons for GI and PLI jointly with $1 - \alpha = .95$.

$$P\begin{bmatrix} .0776 \leq (\mu_E - \mu_F)_{GI} \leq 1.6824 \\ .0540 \leq (\mu_E - \mu_F)_{PLI} \leq 1.4660 \end{bmatrix} = 1 - \alpha = .95 \text{ jointly}$$

DISCUSSION

Most clinicians will readily admit that plaque control is a key factor in the prevention and treatment of periodontal disease. Toothbrushing and flossing are the popular mechanical methods of choice for removing oral debris deposits and plaque from the teeth. However, the thoroughness of plaque and debris removal seems to be more important to the maintenance of periodontal health than is the method itself.

The sophisticated multiple-visit plaque-control programs of periodontal practices and some of the more zealous preventive-oriented general dental offices have been successful because of their continuous reinforcement of patient behavior. However, such programs have not had a very high measure of success in universal general practice.[6]

The findings of the present study indicate that patients who are instructed in good oral hygiene practices by trained dental hygienists in conjunction with oral prophylaxis can be maintained in a high degree of dental health. Moreover, the conscientious use of a fluorescent disclosing system results in a healthier mouth and directly inhibits the recurrence of inflammatory periodontal disease.

This study used and simulated the same level of training as seen in the average dental office in order to achieve results comparable to those achieved in large, active general practices. The therapist and the professionally-trained dental hygienist can motivate patients to assume their portion of the responsibility for the maintenance of good dental health. Specifically, home plaque control is not only possible, but is also significantly effective.

While only reduction in the Gingival Index and Plaque indices were significant statistically, the linear relation of all other index readings showed a marked ability of a fluorescent disclosing system, such as the PLAK-LITE® system to reduce the disease process.

SUMMARY

Two disclosing methods, F.D. & C. Red No. 3 (erythrosin), and D. & C. Yellow No. 8 (PLAK-LITE® Solution of 0.75 per cent fluorescein sodium) were studied for efficacy in a general practice prevention program. Forty-five periodontal patients suffering from either gingivitis or incipient periodontitis were randomly divided into three treatment groups. Treatment and instruction in home care was provided by five senior dental hygiene students. Treatment Group I served as a control and used no disclosant. Treatment Group II used the erythrosin disclosing solution, and treatment Group III used the PLAK-LITE® System (fluorescein sodium solution and disclosing light). All groups received the same oral hygiene instruction and dental prophylaxis. All 6 indices showed a progressive decrease in periodontal disease from control to erythrosin to the PLAK-LITE® System. The plaque scores and gingival scores of Group III patients showed a statistically significant improvement, as compared to those of patients in Groups I and II. The results of this clinical study demonstrated that, in clinical practice, patient home use of the fluorescent disclosing system following oral hygiene instruction and dental prophylaxis can be beneficial.

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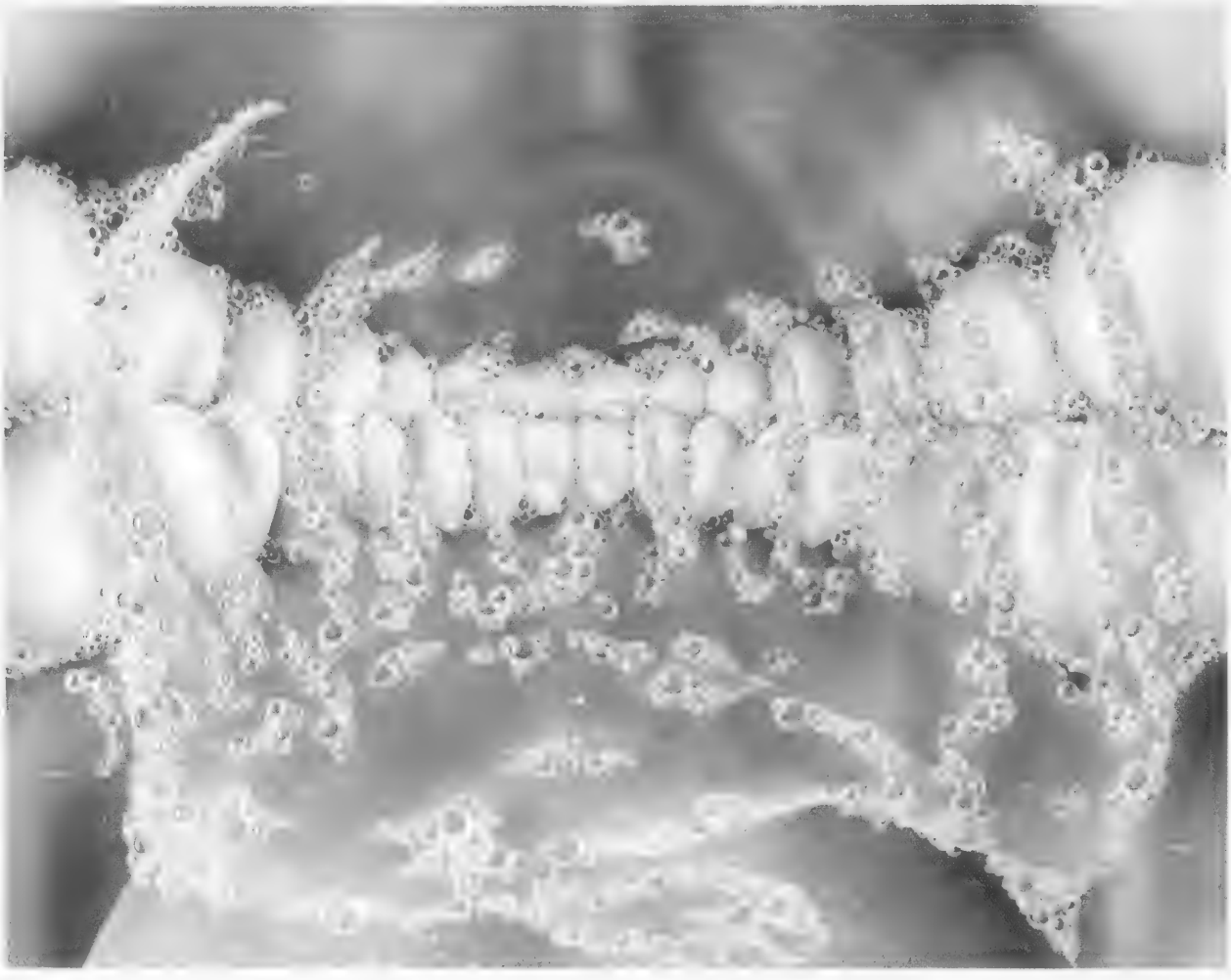

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36% caries reduction. A 3-year study of a similar .05% rinse was later conducted in Britain by Rugg-Gunn, Holloway and Davies.[2] Children ranging in age from 11 to 15 took part. The children were supervised at school as they rinsed for two minutes daily – during the nine month school session only. A 7.5 ml. dose was used. The results showed a 36% DMFS reduction.

27% caries reduction. A third study[3] was done in the United States by Aasenden, DePaola and Brudevold. It was a 3-year study among children 8-11 who rinsed daily in school during the school year only. A 5 ml. dose of a .05% neutral sodium fluoride solution was rinsed for one minute, then swallowed. The results showed a 27% DFS reduction.

Numerous other studies have been conducted using varying concentrations of NaF, intervals between rinses, amounts used per rinse, and rinsing times.[4-9] All of these studies show a reduction in caries.

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How Supplied: 16 fl. oz. (480 ml.)

CAUTION: Federal (U.S.A.) law prohibits dispensing without prescription.

Keep out of reach of children.

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Survey of Preventive Practice by Dental Hygienists 1974

Part II: Behavior and Attitudes Toward Preventive Practice

Lawrence A. Friedman, D.D.S.* and Christine I. French, R.D.H.**

Comparison of a 1974 survey of work habits and attitudes of dental hygienists in Texas[2] with the 1959 report by the National Opinion Research Center[4] reveals that Texas dental hygienists are now working a shorter work week and maintaining efficiency in production. In addition, dental hygienists have expanded their role in preventive dentistry while reducing the time spent in non-dental functions. The survey also showed that dental auxiliaries other than hygienists are participating in office preventive dentistry in increasing numbers.

The present report is confined to that part of the survey which reflects the attitudes and behavior of Texas dental hygienists towards preventive practice, control programs, and topical fluoride application.

MATERIALS

Questions pertaining to current preventive practice were included in a questionnaire sent to all currently licensed dental hygienists employed in the state of Texas. The survey methods have been reported in a preceding paper.[2] Two questions were of the ranking type weighted in terms of the importance placed by the respondent on a specific procedure. All others were multiple choice or yes/no.

RESULTS

Responses pertaining to level of preventive practice (Table 1) disclosed that 37 per cent of the dental hygienists were involved in highly preventive practices, 48 per cent in moderately preventive practices, 13 per cent in "somewhat" preventive practices, and 2 per cent in non-preventive practices.

In response to the question pertaining to the per cent of patients given separate personal oral hygiene instruction (Table 2), characteristic of a control program, structured on a scale of 0, less than 10 per cent, 10–30 per cent, more than 30 per cent, the respondent percentages were 47, 29, 11 and 13, respectively.

In response to the question of the number of appointments provided specifically for personal oral hygiene education (Table 3), another characteristic of a control program, scaled as 0, 1, 2–4, and 5 or more, the respondent percentages were 49, 15, 31, and 5, respectively.

In answer to the question designed to determine when personal oral hygiene education was performed (Table 4), 58 per cent responded that personal oral hygiene education was provided at the time of prophylaxis, 4 per cent that it was given at separate appointments and 38 per cent that it was performed on both occasions.

With respect to preventive measures and treatment currently provided by dental hygienists (Table 5), 97 per cent routinely do the cleaning and polishing of teeth and patient education, 93 per cent take X-rays, 86 per cent give topical fluoride applications, 55 per cent do root planing and curettage, and 11 per cent perform other tasks including nutrition counseling, polishing amalgams, placement of temporary restorations, removal of sutures, myofunctional therapy, vitamin C testing, desensitization procedures, and placement of sealants.

Evaluation of topical fluoride practices (Table 6) revealed that 94 per cent of the dental hygienists apply topical fluoride in the office, 30 per cent recommend self-applied topical

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This survey was sponsored by the Houston District Dental Hygienists' Society.

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Table 1. Dental Hygienists' Ratings of Their Offices' Levels of Preventive Practice

Highly Preventive	37%
Moderately Preventive	48%
Somewhat Preventive	13%
Not Preventive	2%
Total per cent	100%
Number of Respondents	312

fluoride at home, 13 per cent use self-applied topical fluoride in the office, and 3 per cent do not utilize topical fluoride in any manner.

In reporting on the effectiveness of topically applied fluoride, in comparison to other means of combating decay (Table 7), 41 per cent of the dental hygienists in 1974 responded that topical fluoride is about as effective as any other method, compared to 20 per cent in 1959. Comparable 1974 *vs* 1959 percentages for topical fluorides being less effective than any other means were 21 and 36; and for topical fluorides being more effective than any other means were 29 and 34.

In 1959 (Table 8), 97 per cent of the respondents felt that cleaning and polishing teeth was "very important" compared to 82 per cent in 1974. In 1959, only 3 per cent of the respondents felt that cleaning and polishing teeth was "somewhat important" compared to 17 per cent in 1974.

In response to what importance was placed on root planing and curettage (Table 9), 63 per cent responded it was a "very important" service, 34 per cent that it was a "somewhat important" service and 3 per cent that it was a "not very important" service. This assessment is based on N = 191, as 121 of the 312 respondents did not answer the question.

Table 2. Average Number of Patients Receiving Separate Education Appointments

Percentage of Patients	Percentage of Hygienists Responding
None	47%
Less than 10%	29%
10% to 30%	11%
30% to 50%	4%
50% to 75%	3%
Over 75%	6%
Total per cent	100%
Number of Respondents	312

Table 3. Average Number of Separate Patient Education Appointments

Number of Appointments	Percentage of Hygienists Responding
None	49
1	15
2–4	31
5	3
More than 5	2
Total per cent	100
Number of Respondents	312

Personal attitudes towards the importance of preventive practices are compared with actual office work behavior in Table 10. The predominant personal attitude was that patient education was the most important function to be performed, followed by cleaning and polishing teeth, scaling, root planing and curettage, X-rays, topical fluorides, nutrition counseling and educational handouts. With respect to office work behavior, cleaning and polishing teeth was the most important function, followed by patient education, X-rays, scaling, root planing and curettage, topical fluorides, educational handouts, and nutrition counseling.

DISCUSSION

This opinion survey clearly shows that Texas dental hygienists consider patient education to be the most important service they perform. Nevertheless, only 4 per cent reported the use of separate appointments for patient education. This divergence reflects the pressures of private practice and the scarcity of control nurses. The control program, described by Barkley[1], Reed[3], and others, requires an auxiliary skilled in the techniques and skills of personal oral hygiene and competent to motivate and educate patients in the need for good oral hygiene. Dental hygienists are accepting these respon-

Table 4. Personal Oral Hygiene Performance

	Percentage of Hygienists Responding
At the time of prophylaxis	58
At a separate appointment	4
Both	38
Total per cent	100%
Number of Respondents	312

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Table 5. Proportion of Routine Preventive Measures Practiced by Dental Hygienists

Preventive Measure Performed	Percentage of Hygienists Performing the Preventive Measure
Cleaning and polishing teeth	97
Patient education	97
Taking X-rays	93
Topical fluoride application	86
Curettage and/or root planing	55
Other preventive measures*	11

* Nutritional counseling, polishing amalgams, placement of temporary restorations, removal of sutures, myofunctional therapy, vitamin C testing, desensitization procedures, and the placement of sealants.

sibilities and are performing this service at the time of prophylaxis.

Evaluation of Tables 1 to 4 points to the possibility of formally expanding the periodic prophylaxis visit to include the benefits of a control program. If dental hygienists increase the time spent during a periodic recall appointment, a sufficient amount could be included to educate and motivate the patient to practice more effective oral hygiene. If multiple appointments are needed to complete prophylaxis and/or root planing and curettage, education and motivation could be provided at these appointments until an effective level of oral hygiene is reached. These changes would overcome the need for a qualified control nurse and achieve the objectives of a preventive practice. A redefinition of productivity for dental hygienists would then also be in order. The greatest amount of time would be spent with new and young patients. The older and previously educated patient would require less time which could be taken during a routine maintenance prophylaxis. This is an acceptable alternative to a "control nurse" and "control program."

Table 6. Type of Topical Fluoride Utilized

	Percentage of Hygienists Responding
Professional applied topical fluoride in the office	94
Recommend self-applied topical fluoride at home	30
Self-applied topical fluoride in the office	13
Do not use any topical fluoride	3
Number of Respondents	312

Table 7. Dental Hygienists' Attitudes Toward the Effectiveness of Topical Fluoride Compared to Other Means of Combating Decay

	1959	1974
More Effective	34%	29%
Less Effective	36%	21%
About the Same	20%	41%
Don't Know	10%	9%
Total per cent	100%	100%
Number of Respondents	N = 59	N = 312

Until recently, most patients have placed the responsibility for the maintenance of the oral structures on the dentist. With the increased emphasis on preventive dentistry, more and more practices are attempting to cope with the increased demands by providing formal and/or informal patient education programs. Those which include a control nurse utilize control programs to establish a preventive practice. Those offices not having a control nurse or control program are limited to using the dental hygienist to provide the thrust of preventive practice. The dental hygienist is in turn limited by the need to treat large numbers of patients, as evidenced by the response that in most offices greater importance was placed on cleaning and polishing teeth than on patient education.

Gingival treatment (root planing and curettage) was ranked third in personal importance by the respondents (Table 7) and fourth in actual performance in the office. There is an increased awareness of the need for gingival treatment (Table 9) and the dental hygienist is beginning to respond to that need. Similarly (Table 5), 11 per cent of the respondents routinely provide services such as nutrition counseling, polishing amalgams, placement of temporary restorations, removal of sutures, myofunctional therapy, vitamin C testing, desensitization procedures,

Table 8. Comparison of Importance of Cleaning and Polishing Teeth

Attitude	Cleaning and Polishing	
	1959	1974
Very important	97%	82%
Somewhat important	3%	17%
Not very important	—	1%
Total per cent	100%	100%
Number of Respondents	N = 59	N = 312

Table 9. Importance of Root Planing and Curettage

Very important	63%
Somewhat important	34%
Not very important	3%
Total per cent	100%
Number of Respondents	191

and placement of sealants. These stem from changes in the State Dental Practice Act, better professional preparation of the dental hygienist, and the influence of continuing education courses for dental hygienists.

The decrease in the importance placed by dental hygienists on cleaning and polishing teeth (Table 8) is compatible with the changing scope of preventive dentistry. Hygienists are placing more importance on patient education, including plaque control and nutrition counseling, and less importance on routine prophylaxis. It is safe to assume that changes in the philosophy of preventive dentistry, in the educational curriculum and in the quality of continuing education have affected the philosophical change of the dental hygienist.

Topical fluoride application represents an area which has been almost fully delegated to the dental hygienist. It is performed routinely (Table 5) by 86 per cent of the respondents and is considered at least on a par with other methods of combating decay by 70 per cent of those surveyed (Table 7). Most practices are using topically applied fluorides as a caries preventive measure. The data show that many dental hygienists are using more than one technique for topical application of fluoride and that reliance is being put on self-applied topical fluoride.

The lack of importance attached to nutrition counseling and the distribution of educational literature (Table 10) indicates that these approaches have not been effectively included in preventive practice. The reasons for the low priority placed on nutrition counseling and distribution of educational material are unclear and in need of further evaluation.

SUMMARY

Nine-hundred questionnaires were sent to dental hygienists licensed and practicing in Texas. Three hundred-twelve were returned and tabulated. The majority of dental hygienists feel that their offices' practices are highly or moderately preventive in nature. Dental hygienists are accepting the responsibilities of personal oral hygiene education in preventive practice. The bulk of personal oral hygiene education if being performed at the time of prophylaxis. Dental hygienists are expanding their duties to include root planing and curettage, nutrition counseling, polishing amalgams, placement of temporary restorations, the removal of sutures, myofunctional therapy, vitamin C testing, desensitization procedures, and the placement of sealants. Their personal attitudes towards seven preventive procedures did not coincide with the attitude of their offices towards the same procedure. Dental hygienists are aware of and are responding to the need for gingival treatment (root planing and curettage). Dental hygienists are using more than one technique for the topical application of fluoride; however, there is still a greater emphasis placed on the use of professionally applied topical fluoride than on the use of self-applied topical fluorides. Nutritional counseling and the distribution of educational literature have not been effectively included in preventive practice.

Table 10. Rating of Importance of Preventive Measures: Personal Attitude vs. Rating of Office

Rating	Personal	Office
1	Personal patient education	Cleaning and polishing teeth
2	Cleaning and polishing teeth	Personal patient education
3	Scaling, root planing and curettage	Use of X-rays
4	Use of X-rays	Scaling, root planing and curettage
5	Topical fluoride application	Topical fluoride application
6	Nutritional counseling	Educational handouts
7	Educational handouts	Nutritional counseling

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Nutritional Deficiencies:

*A Laboratory Mystery?**

Carl Alper, Ph.D.**

The nutritional assessment of populations received its impetus in modern laboratory medicine after World War II. The medical and nutritional needs and the course of therapy and recovery of prisoners-of-war and victims of concentration camps provided the experimental need and design for extensive studies. Since that time many nutritional surveys have been made, the results of which have clearly identified malnutrition in the United States.[1,3,6] Thus even in a developed country there are (1) pockets of poverty with their attendant general malnutrition of want and malnutrition of excess in addition to (2) malnutrition due to food faddism, (3) malnutrition in the aging population due to poor dentition and the special nutritional requirements of the chronic illnesses of the aged, and (4) malnutrition in mother, fetus, infant and the adolescent due to the special nutritional requirements of growth, development, pregnancy and lactation.

Recently, prominent nutritional scientists have discussed the Nutritional Policies and National Goals for the United States in the 1970's.[5] The foremost goal of a national nutrition policy is to develop a program and mechanism to identify malnutrition, its causes, distribution and ecology. Secondly, the policy must develop programs to "conquer" malnutrition in our society by a direct attack on the problem and by the indirect means of intensive nutrition education.

NUTRITIONAL ADEQUACY AND THE BIOCHEMICAL PROFILE

An examination of the equation of Nutritional Adequacy and Biochemical Profile (inside spread) will indicate the complexity of establishing nutrient needs. In addition to the basal requirements, the food supply must also provide for added balanced needs which will cope with daily physiological requirements and daily or occasional needs due to pathophysiologic stresses. Impinged on these requirements are socio-economic, religious, psychological and physiological factors which may interfere in the selection of the proper food sources or cause adequate nutrients which have been ingested to be physiologically unavailable.

THE COMPLEXITY OF THE ASSESSMENT OF NUTRITURE

Figure 1, which relates Vitamin A intake to the growth rate of an experimental animal, illustrates the complexity of assessing the nutrient requirement if the physiological role of the nutrient or its biochemical role at the cellular level is not understood.

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* Reprinted from The Condenser, Bio-Science Laboratories 4:4, December, 1973.

** Bio-Science Laboratories, 116 S. 18th Street, Philadelphia, PA. 19103.

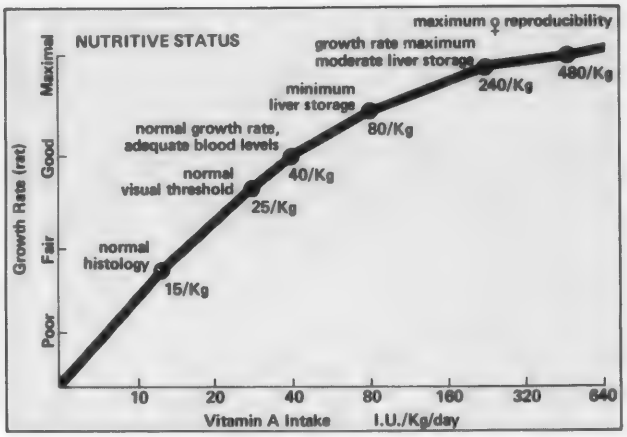


FIGURE 1.

Figure 2 shows the time sequence in the development of a vitamin deficiency. This graph is based on thiamine depletion studies in human volunteers. One can readily relate the depletion of thiamine stores of altered cell metabolism resulting in clinical signs and finally leading to the onset of anatomic defects, the terminal stage in the development of a deficiency.

These figures demonstrate that *nutrient stores must be depleted before depressed blood levels of the nutrient are seen* and that *anatomic pathologic changes occur later in the path of nutrient deprivation than depressed blood levels.*

Similarly Herbert[2] demonstrated that serum folic acid, urine formiminoglutamic acid (FIGLU) and red cell folic acid were depressed before the onset of anatomic changes in an experimental study of folate deficiency in man. Within seven weeks, the period of tissue desaturation, serum folate levels dropped below 3 ng/ml and the polymorphonuclear leucocytes showed hypersegmentation of the nuclei (lobe average >3.3). Biochemical lesions showed up in three months with a high urinary FIGLU (>50 mg/24 hrs) after a 20 g loading dose of histidine. By four months the RBC folate level had dropped to <20 ng/ml. Anatomical lesions and clinical signs of a deficiency appeared within 4–4½ months, revealing a megaloblastic marrow and anemia.

WHAT SHOULD THE LABORATORY MEASURE?

Further study will illustrate the nature of the diagnostic indices (qualitative and/or quantitative) of value to assess nutriture and to define the biochemical profile.

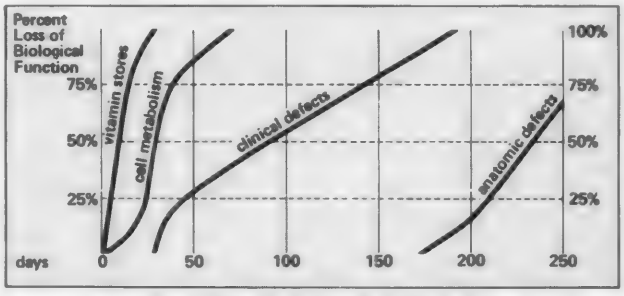
Table 1. Nutritional Diagnosis

1. Medical History (Including environmental exposure)
2. Dietary History
3. Physical Examination
4. Laboratory Examination (a) Biochemical Profile (b) Selected Laboratory Examination

The artist looks at the physical profile of an individual and sees in his mind's eye identifying features which make the individual recognizable to him and to his public. The clinician must look at the pool of biochemical metabolites circulating in the body fluids and stored in the body depots, which represent for each individual the end product of his nutriture and metabolism. The biochemical assessment of the composition of the pool is a "biochemical profile" characteristic of the individual. All too often there is no past history of biochemical assessment of the individual and thus the profile must be compared only to sets of population norms. A comparison of normal values and values used as indices of nutritional deprivation are usually so far apart that the determination of serious malnutrition is not difficult, although marginal malnutrition may be equivocal.

If the nutrient intake of an individual is below the required level for some length of time, the tissue stores are depleted of essential nutrient. At the site of cellular activity where the specific nutrient is required there follows a biochemical derangement with the ultimate impairment of an enzymatic function and the production of either

THE STAGES IN THE DEVELOPMENT OF A VITAMIN DEFICIENCY
(Based on Thiamine Depletion in Volunteers)



Adapted from J. Marks, The Vitamins in Health and Disease, Little, Brown and Co., Boston 1968 – p. 19

FIGURE 2.

The Individual's Biochemical

(1.) Health Status (2.) Nutritional Adequacy

REQUIRED NUTRIENTS:

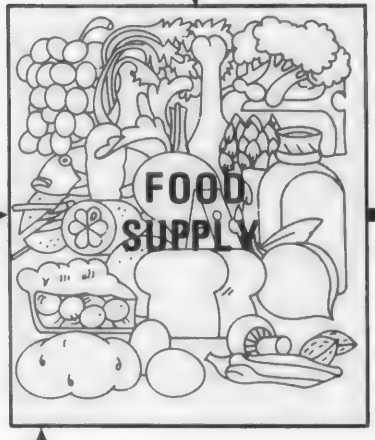
- Oxygen
- Water
- Protein
- Carbohydrate/Lipid
- Vitamins
- Minerals
- Trace Elements

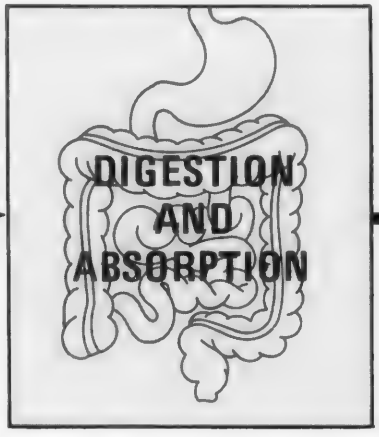
AFTER ABSORPTION THE NUTRIENT IS:

1. Transported to storage sites, e.g., adipose tissue.
2. Transported to metabolic sites, e.g., Liver.
   - A. Distribution Kinetics.
   - B. Inadequate utilization, due to:
     - (1) Metabolic defect.
     - (2) Nutritional deficiency.
   - C. Bio-transformation and distribution of metabolic products.
   - D. Lost via excretion (e.g., renal tubular damage in drug addicts).

PHYSIOLOGICAL REQUIREMENTS FOR NUTRIENTS:

1. Basal needs.
2. Optimal work performance.
   - A. Relationship to physical activity.
3. Added needs to cope with stressful conditions.
   - A. Periods of rapid growth (children)
   - B. Pregnancy/lactation.
   - C. Patho-physiologic stress.
   - D. Psychic stress.
   - E. Convalescence, tissue repletion and nutrient repletion.
   - F. Drug therapy.





FOREIGN MOLECULES:

1. Food additives.
2. Drugs.
3. Ecologic poisons (e.g.).
   - A. Pesticides, Herbicides.
   - B. Mercury in fish.
   - C. Lead, Cadmium, Copper, Nitrates in water supplies, Cooking utensils, etc.

(Factors leading to inadequacies)

NUTRIENT INTAKE IS AFFECTED BY:

1. Socio-economic availability.
   - A. Failure in food production.
   - B. Food storage losses.
   - C. Poverty.
2. Food fads, habits and selection.
3. Physiological and emotional well being.
   - A. Loss of appetite.
   - B. Lack of incentive, apathy, anorexia.
   - C. Dental problems.
   - D. Pregnancy illness.
4. Food preparation.
5. Geographic location.
6. Alcoholism.
7. Drug addiction.

THE BIOCHEMICAL/ PHYSIOLOGICAL FUNCTIONS ARE AFFECTED BY:

1. Disease of malabsorption/liver.
2. Illness and emotional stress.
3. Iatrogenic phenomena.
   - A. Drug-induced vitamin deficiencies.
   - B. Individualized drug-induced physiological response.
4. Genetic factors.
5. Environmental factors.
   - A. Parasitic infections.
   - B. Ecologic poisons.

THE INDIVIDUAL'S BIOCHEMICAL PROFILE/BASELINE: MEASUREMENT BY LABORATORY TESTS

1. BLOOD

- A. Nutrient or metabolite levels
- B. Enzyme activity
- C. Hormone levels
- D. Inorganic elements
- E. Drug/Drug metabolite levels
- F. Ecologic poisons levels

2. CEREBROSPINAL FLUID

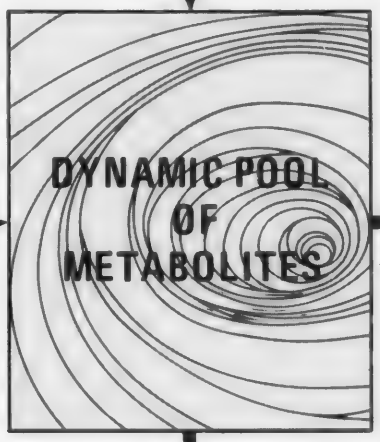
- A. Nutrient or metabolite levels
- B. Drug/Drug metabolite levels
- C. Electrolyte levels

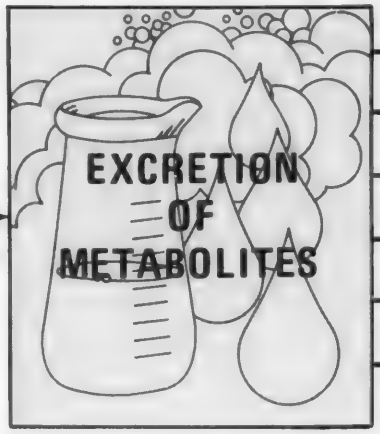
Profile for the Assessment of:
(3.) Drug Level/Drug Therapeutic Efficacy.

FACTORS INFLUENCING THE SIZE OF BIOCHEMICAL POOL OF NUTRIENTS AND/OR DRUGS:

1. Nutritional equilibrium and imbalance.
2. Endocrine control of metabolism and homeostasis.
3. Effects of disease on biochemical homeostasis.
4. Individualized response of metabolism to pharmacodynamic action of drugs.
5. Kinetics of distribution and equilibrium between vascular compartment (blood) and other body fluid compartments and depot sites.

Free metabolite/nutrient/drug ⇌ Bound





BIOCHEMICAL/ METABOLIC CLEARANCE RATE: MEASUREMENT BY LABORATORY TESTS

MILK: Metabolite levels
Electrolyte levels

FECES: Metabolite levels
Electrolyte levels

BILE: Metabolite levels
Electrolyte levels

SWEAT: Electrolyte levels

RESPIRATORY GASES:
Electrolyte levels

URINE:

A. Random specimen: presence or absence of a metabolite, qualitatively significant

B. Timed or 24-hour excretion

1. Total nutrient/metabolite or electrolyte.
2. Total hormone content.
3. Total drug or drug metabolite.
4. Total ecologic poison or metabolite.

METABOLITES USED FOR:

1. Growth.
2. Repair.
3. Maintenance.
4. Responses to the stresses of living.

3. AMNIOTIC FLUID
A. Bilirubin metabolites
B. Lipid ratios
C. Enzymes

4. SYNOVIAL FLUID
A. Crystal structure studies

5. SALIVA
A. Nutrient or metabolite levels
B. Enzyme activity
C. Drug/Drug metabolite levels

Table 2.

Nutrient	Clinical Syndromes Associated With Deficiencies	Biochemical Role	Physiological Role	Laboratory Tests
Protein	Underweight, underheight, lethargy, anemia, edema, fatty liver.	Biosynthesis of cell proteins, protein hormones, etc.	Maintenance of structural integrity and colloid osmotic pressure	Serum protein Serum albumin Urea nitrogen Hemoglobin
Carbohydrates Lipids	Underweight, underheight, lethargy, anemia, edema	Energy metabolism. Biosynthesis of polysaccharides, cholesterol and other steroids, fatty acids.		Carbohydrates Glucose, fasting Glucose tolerance Lipids Cholesterol Triglycerides, fasting
Vitamin A	Growth failure, night blindness xerophthalmia, follicular hyperkeratosis.	Formation of Rhodopsin	Maintenance of epithelial integrity and rod vision	Vitamin A, serum Carotene, serum
Vitamin D	Rickets – children; Osteomalacia – adults; Stunted growth; Osteoporosis – aged		Calcium and phosphate metabolism; Bone growth and development.	Alkaline phosphatase – adults Calcium, serum – adults Phosphate, serum – adults Alkaline phosphatase – children Calcium, serum – children Phosphate, serum – children
Vitamin E	Largely unknown. Muscle changes/creatinuria.	Antioxidant for lipids. H transfer in intracellular respiration.	Integrity of: Vascular system Central nervous system Muscle Normal fertility and gestation	Vitamin E (α-Tocopherol) Erythrocyte hemolysis
Vitamin K	Decreased prothrombin time; Increased coagulation time, Hemorrhages	H transfer	Integrity of clotting factors	Prothrombin time
Ascorbic Acid (Vitamin C)	Scurvy, anemia, hemorrhagic disorders, impaired wound healing.	Oxidation–Reduction systems	Integrity of intercellular substances, metabolism of amino acids, adrenal cortical function.	Ascorbic acid, serum – adult – children
Thiamine	Anorexia, beriberi, polyneuropathy, cardiomyopathies.	Thiamine pyrophosphate as coenzyme	Oxidative decarboxylation reactions. Transketolase reaction.	Pyruvic acid, blood Lactic acid, blood Thiamine, blood Thiamine, urine – adult children < 4 yrs. 4-5 yrs. 6-9 yrs. 10-16 yrs.
Riboflavin	Oral lesions, ocular lesions, glossitis, dermatitis.	FMN, FAD as coenzymes in oxidative cycle	H electron transport between pyridine nucleotides and cytochromes.	Riboflavin, RBC Riboflavin, urine – adult
Niacin	Pellagra, dermatitis, diarrhea, mental confusion, oral lesions, anorexia	NMN, NAD, NADP as coenzymes in oxidative cycle.	H and electron transport between substrate and flavin nucleotides.	N-Methyl Nicotinamide
Vitamin B_6 (Pyridoxine)	Anemia, convulsions (infants), Polyneuropathy, seborrheic eczema.	Pyridoxal ~ PO_4 Pyridoxamine ~ PO_4 Coenzymes in amino group transfer and decarboxylation.	Coenzymes in amino acid metabolism. Coenzyme for desulfurases, kynureninase, etc	Kynurenic acid Xanthurenic acid after 10 g D-L tryptophan
Pantothenic Acid	Burning feet syndrome, impaired motor coordination, muscle cramps.	Coenzyme A Coenzyme in acyl group transfer	Biosynthesis and degradation of fatty acids, cholesterol, other sterols; entry of 2C-fragment into citric acid pathway.	
Biotin	Seborrheic dermatitis, muscle cramps, anemia, anorexia.	Carboxyl group transfer.	Fatty acid synthesis.	
Folic Acid	Glossitis Nutritional macrocytic anemia Megaloblastic anemia: infancy pregnancy	Formyl group transfer.	Biosynthesis of purine bases, histidine, choline, serine.	Formiminoglutamic acid after 15 g L-Histidine Folic acid, serum Folic acid, RBC
Vitamin B_{12}	Glossitis, peripheral neuropathy, macrocytic anemia.	Carboxyl group displacement, reduction of 1-C fragments.	Interrelated function with folic acid. Biosynthesis of labile methyl groups; fatty acid synthesis.	Methylmalonic acid Vitamin B_{12}, serum
Iron	Anemia, glossitis, achlorhydria.	Hemoglobin Porphyrin enzymes	Oxygen transport Oxidation cycle (cytochromes)	Iron, serum – adult – 4 mo.-2 yr. Iron, urine Iron-binding capacity – adult – 4 mo.-2 yr. Transferrin
Iodine	Simple goiter	Triiodothyronine Thyroxine Iodoproteins	Thyroid control of metabolism.	Thyroxine by CPB Urinary Iodine
Calcium	Osteomalacia Senile osteoporosis	Ionic Ca^{++} as enzyme activator	Skeletal system bone formation.	Calcium, serum Calcium, urine
Magnesium	Tetany Neuromuscular irritability	Mg^{++} as enzyme activator	Structure of intracellular fluid compartment. Skeletal system.	Magnesium, serum Magnesium, urine
Copper	Derangement of growth and metabolism.	Cuproenzymes Cuproproteins	Normal development of central nervous system.	Copper, serum – adult Copper, serum – infant/child Copper, urine
Zinc	Defective wound healing, defects in protein synthesis, anemia.	Zinc enzymes	Activator proteinases, carbonic anhydrase, alkaline phosphatase.	Zinc, serum Zinc, urine
Manganese	Defective growth.	Mn^{++} enzymes		Manganese, serum

Normal Range	Findings Suggestive of Deficiency
6.6-8.3 g/100 ml. 3.5-5.0 g/100 ml. 8-26 mg/100 ml. M = 13-18 g/100 F = 11-16 g/100	< 6.0 g/100 ml. (function of age) < 2.8 g/100 ml. < 5 mg/100 ml M = < 12.0 g/100 (function of age) F = < 10.0 g/100
Serum: 70-110 mg/100 ml. Fasting: < 110 mg/100 ml. 3 hour = or < fasting age 30: 120-290 mg/100 ml. age 40: 135-315 mg/100 ml. age 50: 150-340 mg/100 ml. 30-135 mg/100 ml.	In malabsorption, little increase.
65-275 I.U./100 ml. or 20-60 μg/100 ml. 50-300 μg/100 ml.	< 10 μg/100 ml. (10-19 μg/100 low) < 20 μg/100 ml. (20-39 μg/100 low)
35-48 IU/L 4.6-5.5 mEq/L 2.5-4.8 mg/100 ml. 90-230 IU/L 5.0-5.7 mEq/L 4.0-7.0 mg/100 ml.	 < 4.6 mEq/L < 2.5 mg/100 ml. Decreased Decreased Decreased
0.5-2.0 mg/100 ml. Normal	Decreased Increased
	Prolonged over normal
0.2-2.0 mg/100 ml. 0.5-1.5 mg/100 ml.	< 0.1 mg/100 ml. (0.10-0.19 low)
0.3-0.9 mg/100 ml. 5-20 mg/100 ml 1.6-4.0 μg/100 ml. 270-780 μg/24 hr.	Increased Increased Decreased < 27 μg/g creatinine – adults < 120 μg/g creatinine < 85 μg/g creatinine < 70 μg/g creatinine < 55 μg/g creatinine
> 20 μg/100 ml. > 80 μg/100 ml	Decreased Decreased
1.6-4.3 mg/g creatinine > 5 mg/24 hr.	Decreased < 3 mg/24 hr.
up to 3 mg/24 hr. up to 3 mg/24 hr. < 30 mg/24 hr.	Increased Increased > 50 mg/24 hr.
< 3.0 mg/24 hr. 1-8 mg/8 hr. 5-21 ng/ml. 166-640 ng/ml.	Increased Increased Decreased: < 3.0 ng/ml. Decreased
< 10 mg/24 hr. 330-1025 pg/ml.	Increased Decreased
65-175 μg/100 ml. 40-100 μg/100 ml. Under 0.15 mg/24 hr 250-410 μg/100 ml. 100-400 μg/100 ml. 0.2-0.3 g/100 ml.	Decreased: < 50 μg/100 ml. Decreased Increased: > 450 μg/100 ml.
3.0-7.0 μg/100 ml. as I^- 4.6-10.7 μg/100 ml. as T_4 > 50 μg/g creatinine	Decreased < 25 μg/g creatinine
4.6-5.5 mEq/L 2.5-20 mEq/24 hr.	Decreased Decreased
1.3-2.1 mEq/L 1.2-24 mEq/24 hr.	Decreased Decreased
M = 70-140 μg/100 ml. F = 85-155 μg/100 ml. 30-150 μg/100 ml. 15-50 μg/24 hr.	Decreased Decreased Decreased
55-150 μg/100 ml. 0.15-1.2 mg/24 hr.	Decreased Decreased
0.08-0.26 μg/100 ml.	

an abnormal metabolite or a normal metabolite in abnormal quantities. The biochemical assessment of nutriture can be carried out in the following ways: (1) measurement of the circulating nutrient content or its metabolite in bloods (2) measurement of the urinary excretion rate of the nutrient or its metabolite; (3) measurement in blood or urine of abnormal metabolic products resulting from deficient or submarginal intake of nutrients; (4) measurement of changes in enzyme activities or concentration changes in normal metabolites that can be related to the deficient intake of the nutrient; and (5) metabolic response to a biochemical load (saturation test) of a metabolite or vitamin to assess biochemical function. (The load test can serve as a therapeutic trial and in that way the clinician may differentiate between a deficiency syndrome or inadequate biochemical utilization of the nutrient.)

NUTRITIONAL SCREENING VS INDIVIDUAL NUTRITIONAL ASSESSMENT

In the screening of a population for deficiences, the nutritional biochemist and the physician, knowing something about the dietary habits and the state of health of the population being studied, may select specific nutrients for analysis. The goal is to rule out nutritional deficiency and as a consequence the measurements are designed to identify those individuals who are deficient or marginally deficient. Thus they would select a population sample and a set of assays which will pinpoint the problems about which they are concerned. As a consequence, a first morning urine and/or a fasting blood sample are the specimens of choice. It is only after the screening procedure indicates a problem that the use of load tests, liver biopsy (if appropriate), assay of 24-hour urines or red cell and/or white cell metabolites are used to elaborate the nutritional defect.

In a ten-state nutrition survey[6] the following measurements were made on each individual: hemoglobin, hematocrit, serum iron, transferrin, serum folic acid/red cell folic acid, serum protein and albumin, Vitamin A and carotene. Vitamin C, riboflavin, thiamine and iodine. The results indicated that a significant proportion of the population surveyed was malnourished or borderline malnourished. Blacks and Spanish-Americans more so than Whites. Iron deficiency anemia was widespread; obesity was prevalent; undersized children were found in all population groups; there appeared to be general malnutrition in persons over 60; adolescents, especially males,

exhibited the highest incidence of general malnutrition; and Vitamin A deficiency was prevalent among pregnant and lactating women.

The survey also demonstrated that nutritional deficiencies are often not limited to single essential nutrients. A significant number (>10%) of individuals surveyed demonstrated two or more deficiencies and in some instances as many as four from a limited group of six measurements. Again Blacks and Spanish-Americans showed a greater incidence of multiple deficiencies, averaging almost three times the occurrence found in Whites.

In the initial assessment of anemias as a nutritional problem, the results of a complete blood count, hemoglobin concentration and hemotocrit indicate the presence of anemia. The next step is to assess the nutritional adequacy of iron by the determination of serum iron and transferrin. Transferrin is a protein subject to adequate protein ingestion and specific protein synthesis. The next steps are to determine the Vitamin B_{12} level, the adequacy of folic acid in the diet by assessing serum and red cell folate, and the accumulation of formiminoglutamic acid (FIGLU) after a histidine load.

THE EXAMINATION OF THE INDIVIDUAL

For the individual patient, the examining physician can follow the sequence listed in Table 1. If the thorough clinical examination, with a dietary and medical history, incites his index of suspicion by the presence of characteristic clinical signs, thinking nutritionally and biochemically, he will select the biochemical studies which will pinpoint the nutritional deficiencies, if any.

The physician may have previous laboratory information (a biochemical profile) available for comparison. Laboratory results obtained against this background of past history will aid in the diagnosis of a nutritional deficiency. Table 2 summarizes the role of protein and calories, fat-soluble vitamins and minerals, along with the significant findings of each which are suggestive of nutritional deficiency.

SUMMARY: NUTRITIONAL DIAGNOSIS

The complexity of nutritional problems which require assessment of the adequacy of about 24 essential nutrients and the delineation of nutritional fault or metabolic abnormality is challenging not only to the physician, but also to the laboratory scientist. New knowledge and understanding of the intricate steps in intermediary metabolism, the interrelationship of metabolic pathways, the availability of new analytical instrumentation and the development of new analytical techniques allow us to measure the circulating nutrient level (an index of nutrient intake and adequate nutrient absorption), abnormal or normal metabolites (an index of nutrient utilization or metabolic aberration due to nutritional fault), enzyme activity in selected body fluids or biopsy specimens (an index of nutrient utilization as enzyme cofactors), and hormone activity in selected body fluids (an index of metabolic adaptation in the presence of nutritional deprivation.)

Table 2 includes a list of the various laboratory tests available to clinicians today which can aid in diagnosis and follow-up in problems involving nutritional deficiences.

Nutritional diagnosis should be integrated into and become part of the physical examination and study of patients with medical diagnostic problems.

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The Effect of Dextranase on Oral Health in Children

Luis F. Duany,* Doran D. Zinner,* Julio C. Mena,* and Jose M. Gonzalez**

The ability of several strains of streptococci to form sticky, extracellular polysaccharides (glucans) on the teeth of experimental animals and to induce caries is well known[5,8,15]. The glucan-producing organisms have been found in human dental plaque[7]. These findings indicate that microbial glucan-formation may play an important role in the formation of dental plaque and in the induction of caries in humans[4]. Some investigators have shown that the addition of an enzyme, dextranase, to the diet or drinking water of hamsters results in plaque reduction and the prevention of caries under otherwise caries-conducive circumstances[6]. A long-term study with dextranase, done on monkeys, resulted in caries reduction in the experimental animals[1]. However, in humans, short-term clinical trials have shown that the enzyme has limited anti-plaque activity[10,12], and others found no measurable effect on plaque score or plaque weight[2]. In addition, a Scandinavian clinical trial with glucan hydrolases did not result in plaque reduction following the use of the enzyme[9]. This study was intended to assess the effect of the enzyme when applied for a prolonged period of time.

METHODS

The study population consisted of 493 students, ages 7–13, attending an elementary school in Loiza, Puerto Rico. The initial mean age of the three study groups was the same; 9.3 years. The population has a low mobility rate and resides in a confined geographic area. Drinking water was found to contain 0.2 ppm fluoride.

Children were randomly allocated to one of three study groups: **Group I**-Dextranase-N = 164; **Group II**-Placebo-N = 170; **Group III**-No treatment-N = 159

Children were examined twice annually, by the same examiner, without reference to the previous examination results. During the clinical examination an entry was made for every surface of each erupted tooth on a specially designed optical-scan mark sense form. These entries were made by the same recorder.

Following clinical examinations, two bite-wing radiographs were taken of each child, using standardized techniques of exposure and development. Where discrepancies existed between clinical and radiographic diagnosis, entries were changed (approximal surfaces only) with the radiographic evidence taking precedence.

Gingivitis was evaluated at each examination, using the gingival portion of the Periodontal Index[13]. After staining the four maxillary incisors with a 5 per cent aqueous solution of Fast Green #3, extent of plaque accumulation was assessed at each clinical examination, using a plaque index which ranged from zero to four[3]. The caries status of each tooth surface was recorded[11].

Prior to the beginning of the study, September 1970, each child received a prophylaxis by a dentist. However, daily treatments did not begin until late October because of flood damage to the school, and twice a day applications were not instituted until late January 1971. No prophylaxis was given at the start of the second year of the study. Treatment was carried out over the length of the school year (September-May), but not during the summer vacation period. During early morning and early afternoon of each school

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This study was supported by the National Institute of Dental Research, NIH, No. 71-2013-02.

This paper was presented in part at the 51st General Meeting of the International Association for Dental Research, Washington, D.C., April 12, 1973.

Table 1. Means and Standard Error for DMFS, P.I. and Extent of Plaque, September, 1970.

Group	N	DMFS		PI		Plaque	
		$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
I-Dextranase	164	2.35	.27	.29	.02	2.22	.07
II-Placebo	170	3.02	.34	.32	.02	2.22	.07
III-Control	159	3.28	.41	.30	.02	2.06	.07
Totals	493						

day, dextranase and the placebo were freshly prepared in a gel base. The dextranase was derived from *Penicillium funiculosum* and prepared by Merck Research Laboratories. Aside from the presence of the enzyme, the composition, viscosity, taste and pH of the dextranase and placebo gel preparations were the same. Packaged materials were identified by a code. The gel base used in the trial was calcium carageenan SI (marine colloids). The gel was prepared by using 5.9 grams of the carageenan plus water to yield 750 ml. This gel was used as the placebo control. The dextranase treatment consisted of the same gel plus dextranase to yield 2,500 units per ml. The dextranase used was approximately 10,000 units/mg. Approximately 2cc of these preparations were spread evenly with a calibrated syringe into both upper and lower vinyl mouth pieces, custom-made for each child (Omnivac V Vacuum Adapter, Omnidental Corporation, Harrisburg, Pennsylvania-Sta-Guard Plastic Sheets, $3\frac{1}{2} \times 6 \times \frac{1}{16}$ inches, Stalite Inc., Hialeah, Florida). The mouth pieces remained on the dentition for 6 minutes at each treatment. The children did not rinse after treatment. Four dental assistants supervised the treatment procedure.

At the onset of the study, 5 children out of a total of 334 refused to continue in the treatment program because of gag-reflex response to the mouth pieces. In general, however, the cooperation of the rest of the children was excellent. Over the length of the study approximately 300 new mouth pieces were fabricated because of the changing dentition.

Four months after the beginning of treatment, plaque samples were gathered from 36 randomly selected subjects, 17 in the dextranase group and 19 in the placebo group. Plaque samples were analyzed for dextranase-released carbohydrate and for dextranase-refractory polysaccharide. Individual determinations of dextran content, based on sufficient sample weights, were performed on 10 and 11 of the samples from the two respective groups. Two pooled determinations were made for the remaining 7 and 8 samples.

The plaque was analyzed by first washing well with water. The insolubles were then treated with dextranase and the solubilized carbohydrate was measured by the anthrone reaction. This was calculated as the dextran content. The insolubles were then extracted with cold 1N. NaOH and the extracted material was assayed by the anthrone reaction. The result was used to calculate the dextranase resistant polysaccharide. The details of these experiments and the analysis of the results will be the subject of another paper.

RESULTS

Of the initial 493 students studied in September 1970, 452 children were examined at the completion of the second year of the program, an 8.3 per cent attrition. Of the 452 students examined at the end of the study, 444 of them had a complete examination record.

The initial dental status of the population studied is shown in Table 1. No significant differences among group means of DMFS, P.I., or plaque were detected.

DMFS net increments are summarized in Table 2. At the end of the first school year differences among the mean net DMFS increments of the dextranase, placebo and non-treatment groups, 0.49, 0.06 and 0.32 respectively, were not statistically significant. During the second school year the mean net DMFS increment for the dextranase group, 0.63, was found to be significantly different from that of the placebo group, which was 1.18, and that of the non-treated group, 1.26. However, analysis of the combined mean net DMFS increments for the two years did not reveal any significant differences among the groups.

During the second year of the program the net incremental DMFS means of subjects with any initial caries was 0.87 for the dextranase group

Table 2. DMF Surfaces Net Increment: All Subjects, September 1970–May 1972.

Group	Sept. 1970–May 1971			Sept. 1971–May 1972			Sept.* 1970–May 1972		
	N	$\bar{X}$	SE	N	$\bar{X}$	SE	N	$\bar{X}$	SE
I-Dextranase	147	.49	.18	144	0.63	.14	146	2.07	.32
II-Placebo	161	.06	.20	148	1.18	.21	151	1.74	.33
III-Control	148	.32	.20	142	1.26	.19	147	2.35	.35
Totals	456			434			444		

* The figures on the Sept. 1970–May 1972 column do not reflect the totals of the figures on the left because DMF surfaces net increment for the three and one half month summer period were not included in Table 2.

(N = 85), and 1.89 for both the placebo (N = 86) and non-treatment groups (N = 86). During the same time interval, incremental DMFS means in previously caries-free students were 0.31 for the placebo (N = 62), 0.38 for the dextranase (N = 59) and 0.45 for the control groups (N = 56).

Changes in mean P.I. scores were analyzed each school year and for the period September 1970 through May 1972. For the first school year the mean change in P.I. for Group III (the non-treatment group) was found to be significantly less than the combined mean for Groups I (dextranase), and Group II (placebo), ($P < 0.05$). However, this difference was not detected during the second year or the total period. The results are shown in Table 3.

Individual differences in plaque score were analyzed for each school year and the total period. Mean differences for the two school years were not significantly different among the groups. However, for the total period both the dextranase and placebo groups showed greater improvement than the non-treatment group. Although there was no significant difference between the change in the dextranase and placebo groups the magnitude of change in the placebo group was greatest for each time period. Results are presented in Table 4.

The dextran content of plaque samples taken from the treatment and placebo groups after 4 months was also different. The mean dry weight dextran contents from individual determinations were 2.4 per cent for the dextranase group (N = 10), and 11.8 per cent for the placebo group (N = 11). The pooled samples from the two groups contained 1.0 per cent and 3.0 per cent for the dextranase (N = 7), and placebo groups (N = 8), respectively.

No adverse reactions of the oral mucosa from the use of either the dextranase or placebo gels were observed throughout the length of the study. In addition, blood analyses on 96 children demonstrated that a twice-daily application of dextranase gel (2500 units per ml), over an 8 month period, did not result in any abnormal blood changes[14].

DISCUSSION

The caries increments for the two-year period were not significantly different among the groups; however, a difference was detected for the second school year. Applications did not begin until late the first year and treatment was limited to once a day for the first 3 months. These condi-

Table 3. Mean Differences for Gingivitis: All Subjects, September 1970–May 1972.

Group	Sept. 1970–May 1971			Sept. 1971–May 1972			Sept. 1970–May 1972		
	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
I-Dextranase	147	−.069	.24	144	−.189	.22	146	−.159	.24
II-Placebo	161	−.110	.26	148	−.193	.25	151	−.202	.26
III-Control	148	−.024	.27	142	−.168	.25	147	−.152	.23
Totals	456			434			444		

Table 4. Mean Differences for Extent of Dental Plaque: All Subjects, September 1970–May 1972.

Group	Sept. 1970–May 1971			Sept. 1971–May 1972			Sept. 1970–May 1972		
	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
I-Dextranase	147	−.301	1.02	144	−.071	.87	146	−.195	1.01
II-Placebo	161	−.303	1.05	148	−.191	.86	151	−.325	1.11
III-Control	148	−.041	1.14	142	−.019	.92	147	−.136	1.04
Totals	456			434			444		

tions might partially explain the difference between the results of the first and second year.

During the second year, subjects with no initial caries showed little difference in increment among groups, whereas the groups were different for subjects having one or more initial carious lesions. Children with one or more initial lesions have a higher DMF increment than those with no initial caries. Thus, when attention is focused on only those children with one or more carious lesions, for whom there is greater caries increment, differences are more likely to be detected.

For this population the P.I. scores reflect gingival conditions. During each time period the placebo group obtained the greatest mean gingival score reduction, followed in descending order by the dextranase and control groups. A mechanical effect of the mouthpieces might explain these results. Reduction in gingival score increased for all groups throughout the two-year period of the study. This may be explained, in part, by the tooth brushing habits of the children. The program stimulated a strong sense of dental awareness among the majority of participants and this led to the acquisition and more frequent use of the toothbrush.

Change in dental plaque was found to be greatest in the dextranase and placebo groups when compared to the control groups. Again, a mechanical effect rather than a dextranase effect is suggested.

Although the number of samples involved is quite small, a comparison of the plaque analyses in the treated and placebo groups indicates that there was a considerable effect of the dextranase on the dextran content of the plaque in the treated group. These findings are evidence that the dextranase was effective in reducing plaque dextran content in spite of the less than optimal conditions under which it was used in the study.

CONCLUSION

There was no significant difference in the caries increment during a 20 month study among groups treated with the enzyme dextranase, compared to a placebo group and an untreated control group. The magnitude of the differences found during the second year of the study was small and it may be a function of a low level of caries activity in the study population.

It appears from the findings from the children, with and without previous caries activity, that the beneficial effect of the enzyme was to slow down the progress of ongoing caries lesions, rather than protecting the caries-free child.

Improvement in the gingival and dental plaque status of the treated groups suggest a mechanical effect of the mouthpieces rather than a consequence of the enzyme.

Studies on the effects of the enzyme on populations with initial higher DMF surface rates and the utilization of another delivery system, may demonstrate more detectable differences.

ACKNOWLEDGMENTS

Dextran determinations were carried out by Dr. Thomas H. Stoudt, Merck, Sharp and Dohme Research Laboratories. The enzyme dextranase was provided by the Merck, Sharp and Dohme Co., Rahway, New Jersey.

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Preventive Dentistry and the Recession

Preventive dentistry can help trim the family budget, a dental expert said today.

Dr. Paul DePaola, Clinical Researcher at Forsyth Dental Center and recognized authority on preventive dentistry, stated that during a recession it is very wise, and actually money saving, to bring children to the dentist for a routine examination and a topical fluoride treatment.

Dr. DePaola declared, "It may be trite, but for children, an ounce of preventive dentistry is worth a pound of dental repair. Conscientious home care, fewer sticky sweets, and topical fluoride applications by the dentist will significantly reduce the amount of tooth decay in children. It will cost less to prevent tooth decay in this manner than to restore the cavities which will form otherwise."

Children's restorative dentistry represents one of the largest outlays of money the young family is faced with during good times, or bad, he said. The Forsyth researcher urged that families have their children seen by the dentist regularly for preventive care, which would result in good dental health at minimal cost to the family.—*From The Daily Item, Melrose, Massachusetts.*

Oral Hygiene in Children: Relationship to Age and Brushing Time

J. R. Pinkham, B.S., D.D.S., M.S.*

The advent of methods for assessing oral cleanliness, such as the Simplified Oral Hygiene Index described by Greene and Vermillion,[2] gave dental researchers the ability to compare oral hygiene status in children to such variables as periodontal health and caries experience. Greene and Vermillion provided evidence that there exists a strong positive correlation between poor oral hygiene and periodontal disease in Caucasian male children.[1] McCauley and Frazier reported a direct correlation between poorer oral hygiene and higher dental caries experience in Caucasian and Negro children of both sexes.[3] Traubman examined 399 children ages 12, 13, and 14 and found a strong positive and significant correlation of poorer oral hygiene scores to the degree of periodontal disease present.[9] The same study noted a weaker, but still significant correlation of oral hygiene exhibited to dental caries and a weak negative and insignificant correlation to dental caries experience.

Despite the widespread acceptance and use of techniques which measure oral cleanliness there does appear a striking scarcity of literature showing children's oral hygiene status relative to yearly age. This is particularly true of the preschool ages which escape observation in the majority of epidemiological studies.

Smith, using the descriptions of good, fair, and poor to identify oral hygiene, studied a population of 1,215 Orientals from 6–22 years of age and tabulated the data in yearly increments.[7] For the age groups 14 years and under he observed that the 14-year-old group had the highest percentage of "good" scores (28.21%) and that the 6-year-old group was next with 24.4%. The 7 year olds had the lowest "good" score, 6.25 per cent, and the highest "poor" score, 50.00 per cent.

Olivieri-Munroe used good, fair, and poor as descriptions for the oral hygiene of 1,181 children in Malta and Gozo.[4] The ages of the children ranged from 5–13 years. In this study the 5-year-olds had the highest percentage of "good" scores. There was a trend for good scores to decrease with yearly age and for the fair scores to increase with age. In a more recent paper, Olivieri-Munroe reported on a survey of a small population of Jordanian Samaritans from ages 4 to over 55 years.[5] This survey found the 11-year-olds to have the highest debris of all age groups as scored by the simplified oral hygiene index of Greene and Vermillion. Ripa, in a study of 9–13-year-olds, reported a trend for oral hygiene to deteriorate with increasing age but found no statistically significant differences according to mean age.[6]

METHOD

Four hundred and twenty-two children from ages 3-13, appointed for a new examination or a recall examination in the University of Iowa College of Dentistry Pedodontic Clinic during the spring semester of the 1972–1973 academic year, were evaluated for oral cleanliness by junior dental students. The technique used to determine each child's OHI score was a modification of the DI-S part of the Greene-Vermillion OHI-S. This OHI technique (Fig. 1) scores plaque stained with erythrosin and debris accumulations from 0 to 3 on the buccal and lingual surfaces of 6 teeth, 4 posterior (second primary molars, or first permanent molars if they are fully erupted) and 2 anteriors (right primary or permanent central incisors).

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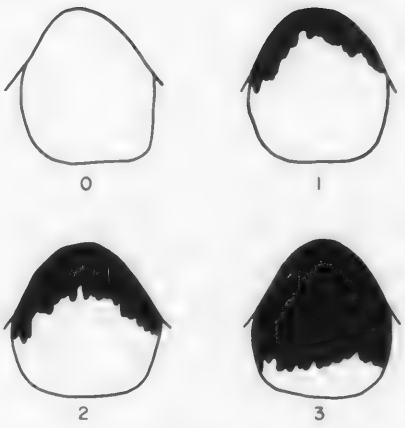

FIG. 1. Criteria for scoring plaque: 0—no plaque; 1—distinct region of stained plaque at gingival margin; 2—stained plaque covering one-third of the tooth surface; 3—stained plaque covering two-thirds or more of the tooth surface.

Possible total scores range from 0 to 36. The participating dental students had been instructed in the use of the index and were assisted by a staff of dental assistants who had been aiding dental students in the use of the index for the previous semester. A total of 34 students and 9 assistants scored the 422 patients.

Since the results of the survey showed a statistically significant relationship between certain age groups, a second part of the investigation was conducted to explain the relationships. To conduct this study 97 new patients between the ages of 4–12 years were given initial OHI scores. They were then instructed to brush their teeth at a sink until they were satisfied that they were clean. This brushing activity was timed to the nearest 15 second increment by the attending dental student. The children were not told that they were being timed. At the end of the brushing activity, when the children had withdrawn the toothbrush from his mouth and finished expectorating, another OHI scoring was performed. Two additional data entries were recorded for the 6 and 7-year-olds in this part of the study. These were the number of permanent teeth used to determine the OHI score and whether the child was enrolled in school.

Children in the age 3 category were not included in this part of the study because of the feeling by the investigator and participating dental students that the majority of these children at 40 months or younger did not understand the instructions regarding brushing. The age 13 category did not have any participants.

RESULTS

Table 1 shows the results of the first part of the investigation. An analysis of variance comparing the means of the 11 groups indicated a statistical difference in the means significant at an F probability of 0.005 {F(10,411) = 2.599}. A Tukey-Honest Significant Difference multiple range test indicated that at the 0.05 alpha level the only significant difference between age group means was between

Table 1. Results of Clinic Survey.

Age	Subjects (N)	Mean OHI Score	SD
3	21	15.6190	6.0949
4	42	12.8095	5.7179
5	48	12.8333	4.5957
6	49	11.9796	4.5345
7	30	16.6667	7.6037
8	45	14.4667	6.4406
9	52	14.7885	4.9362
10	39	12.5385	5.0097
11	41	15.0000	5.3151
12	40	12.4750	6.4965
13	15	13.4000	6.1852

Table 2. "Before Brushing" Results.

Age	Subjects (N)	Mean OHI Score	SD
4	10	15.3000	5.9451
5	11	12.6364	3.6952
6	7	15.0000	5.6273
7	9	22.3333	6.7454
8	14	17.8571	5.1718
9	11	11.7273	3.9011
10	13	14.0769	4.6630
11	15	14.6667	4.9809
12	7	16.7143	6.2374

the 6 and 7-year-olds. Because of distributional considerations a non-parametric test of the 6 and 7-year-olds was used to determine if the 7-year-olds were significantly cleaner. The Mann-Whitney-Wilcoxon U-statistic rejects at an alpha level of less than 0.01 any similarity of the scores. Thus, there is very strong evidence that OHI scores for 7-year-olds are (stochastically) larger than OHI scores for 6-year-olds.

Tables 2–5 show the results of the second part of the investigation. The Pearson Product Moment Correlation obtained from the before and after brushing scores for all 97 cases was .808 (T value, 14.48, with 96 D.F.). This supported a strong indication that the degree of cleanliness for all subjects had little to do with time spent brushing.

An analysis of variance comparing the before brushing means (Table 2) of the 9 groups supported a difference in the means significant at an F probability of 0.001 {F(8,88) = 3.714}. A test for homogeneity of variance revealed no statistically significant differences between the groups. The Tukey-Honest Significant

Table 3. "After Brushing" Results.

Age	Subjects (N)	Mean OHI Score	SD
4	10	12.2000	6.5963
5	11	8.8182	3.0925
6	7	8.2857	2.9277
7	9	15.1111	6.3333
8	14	12.6429	4.3608
9	11	7.6364	3.2334
10	13	9.6923	3.8597
11	15	9.4667	4.7789
12	7	10.4286	4.4293

Difference multiple range test indicated that at the 0.05 alpha level the significant differences between age groups on the before brushing means were between the 7 and 5-year-olds, 7 and 9-year-olds, 7 and 10-year-olds, and 7 and 11-year-olds.

An analysis of variance comparing after brushing means (Table 3) of the 9 groups was significant at an F probability of 0.008 $\{F(8,88) = 2.796\}$. A test for homogeneity of variance revealed no statistically significant differences between the groups. The Tukey-Honest Significant Difference multiple range test indicated that at the 0.05 alpha level the only significant difference between age groups was between the 7 and 9-year-olds.

There was no statistically significant difference between age groups on the variables of mean difference of OHI before and after brushing (Table 4) and on mean time spent brushing (Table 5). The multiple range test supported homogeneity of the groups for these variables.

The number of permanent teeth used in the OHI scores of 6 and 7-year-olds averaged 2.2 permanent teeth for 6 years and 5.9 for 7 years. All the 6 and 7-year-olds were in school.

DISCUSSION

Since the first part of the study showed a significant difference between the OHI scores of the 6 and 7-year-olds, the second part of the study was designed to try to identify the cause for the 7-year-olds having the significantly higher mean OHI score. It was assumed that the manual dexterity or ability to effectively clean the dentition for the 7-year-olds was at least as good if not better than 6-year-olds. This seemed to leave two potential factors that could influence the difference. First, as a group the 6-year-olds might have fewer individuals in school and this would allow them the opportunity to brush and reduce their scores prior to their dental appointment. Second, the 7-year-olds should have more permanent teeth scored in the OHI than the 6-year-olds, and the permanent tooth as opposed to the primary tooth may be either or both a more difficult tooth to clean and a tooth with greater potential for accumulating plaque.

Table 4. Difference Between Before and After Brushing Scores.

Age	Subjects (N)	Mean Change in OHI Score	SD
4	10	3.1000	2.1833
5	11	3.8182	1.9909
6	7	6.7143	3.5923
7	9	7.2222	5.2148
8	14	5.2143	3.7862
9	11	4.0909	2.9480
10	13	4.3846	3.6409
11	15	5.2000	1.8974
12	7	6.2857	3.9461

Although the second part of the study did not show a statistically significant difference between 6 and 7 years, the 7-year-old group did possess a higher mean OHI. Since all the 6 and 7-year-old children were in school, the difference observed in the first part of the study would appear to be due to the presence of more permanent teeth.

Table 5. Time Spent Brushing.

Age	Subject (N)	Mean Time Spent Brushing	SD
4	10	74.5000	30.0416
5	11	88.6364	57.1004
6	7	105.0000	39.6863
7	9	123.3333	94.8025
8	14	112.5000	44.7106
9	11	100.9091	35.5541
10	13	81.9231	71.5757
11	15	92.0000	39.2246
12	7	98.5714	51.1301

The fact that in the second part of the study the 7-year-old group had a significantly higher before brushing OHI than did four other groups, three of which were older, suggests the possibility that changes occur over time with erupted permanent teeth that yield less accumulation of plaque. This supposition, however, was not supported statistically by the first part of the study.

It is interesting to compare this study to one reported by Suomi and his co-workers which compared the plaque removing ability of a standard toothbrush and an experimental toothbrush.[8] Their study used dental hygienists to brush the teeth of 68 kindergarten and 62 second grade school children. Experimental procedure dictated a standardized brushing technique. One of the observations discussed was that regard-

less of the toothbrush used the kindergarten group showed a lower plaque score after brushing than second graders did after brushing. Since before-brushing scores were not taken, the author was unsure whether the kindergarten groups were cleaner before brushing. However, there was the speculation that the mixed dentition might be more difficult to clean than the primary dentition.

Another important finding in this study was the conclusion that the degree of cleanliness for all subjects had nothing to do with time spent brushing. Since this held true for all age groups, a serious question is raised regarding whether any pre-teenage patient can be assumed to be dextrous enough to maintain his own oral cleanliness. Since the older age groups could not effect a significantly greater cleaning in essentially the same amount of time as the younger age groups, the needed parental supervision and participation in the cleaning of the dentitions of all the age groups studied can be encouraged.

SUMMARY

Four hundred and twenty-two children from ages 3–13 were given an OHI scoring to determine mean OHI scores for yearly age intervals. The results showed that the 7-year-old group had the highest mean OHI score, the 6-year-old group had the lowest mean OHI score, and that the only significant difference between all the age group means was between the 6 and 7-year-old groups.

A second part of the study was conducted with 97 children from 4–12 years of age. In this part of the study before-brushing OHI scores were determined, and after a brushing period which was timed but not defined as to length an after brushing OHI was scored. The results were as follows: (1) There was a relatively strong indication that the degree of cleanliness after brushing for all subjects had nothing to do with time spent brushing; (2) The significant differences between age groups on the before brushing means were between the 7 and 5-year-olds, 7 and 9-year-olds, 7 and 10-year-olds, and 7 and 11-year-olds; (3) The only significant difference between age groups on the after brushing means was between the 7 and 9-year-olds; (4) There was no significant difference between age groups on the variables of mean difference of OHI before and after brushing and on time spent brushing.

ACKNOWLEDGMENT

The author gratefully acknowledges the contributions made to the statistical analysis of the data by T. M. Moberg, University of Iowa Statistical Consulting Center, Iowa City, Iowa.

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Margarine and Your Heart

Margarine is being accused of being a worse villain in hardening of the arteries than butter or eggs. The unorthodox indictment, by Fred A. Kummerow, professor of food chemistry at the University of Illinois, and his team, was made at the annual meeting of Federation of Societies for Experimental Biology in Atlantic City.

The problem, Kummerow explains, is that although margarine consists of polyunsaturated acids, many of these acids change from their natural form to an altered form during the hydrogenation process. The altered form of fatty acids appears to be more damaging to arteries than even saturated fatty acids or cholesterol.

Brush-In 74

Christine I. French, R.D.H.

The Texas Chapter of the American Society for Preventive Dentistry sponsored a Brush-In at Memorial City Shopping Center Mall in Houston, Texas, November 30, 1974. A handful of local ASPD members planned and supervised the project with the help and

participation of some seventy volunteers from the Houston District Dental Hygienists' Society, the Houston Dental Assistants' Society, and several dental assisting schools.

The Brush-In was one of the activities planned as part of Tooth Preservation Week. Mayor Fred Hofheinz proclaimed that the week of November 24–30 be declared Tooth Preservation Week. Other activities were planned during that week by the City Public Health Department, the University of Texas Dental Branch, and the Houston District Dental Hygienists' Society.

The Brush-In could be described as a massive control program. Over 700 people viewed films on brushing and flossing, and nutrition, and received individual oral hygiene instructions from dental hygienists and dental assistants. A literature display was available for those interested in further information. A WATER-PIK* display was set up by the local representative. Electric toothbrushes, WATER-PIKS*, PLAK-LITE* Dental Plaque Disclosing Kits, and cans of sugarfree drinks were given as

door prizes. A Mr. Tooth Contest was held in neighborhood schools during the two month period prior to the Brush-In. The entries were judged and winners' entries were displayed at the Brush-In.

Materials for the Brush-In were donated by manufacturers including Procter and Gamble, Oral B, John Butler Co., International Pharmaceutical Corp., Teledyne Aqua Tec, Johnson and Johnson, Texell Products, Lever Brothers, and Block Drug Co.

The goals of the Brush-In were to increase public awareness of the dental community and of the need for dental health education, and to provide a service to the public. Besides accomplishing these goals, the Brush-In demonstrated the effectiveness of a small interested group of professionals in organizing such a project.

The Brush-In has been written up in detail to assist anyone who might be interested in sponsoring another Brush-In. The write-up includes details on contacts, organization, and publicity. If you are interested in

sponsoring a Brush-In and would like a copy, contact Christine I. French, R.D.H., 7600 Highmeadow #42, Houston, Texas 77042.

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* Trademarks: WATER-PIK—Teledyne Aqua Tec, Fort Collins, Colo. PLAK-LITE—International Pharmaceutical Corp., Warrington, Pa.

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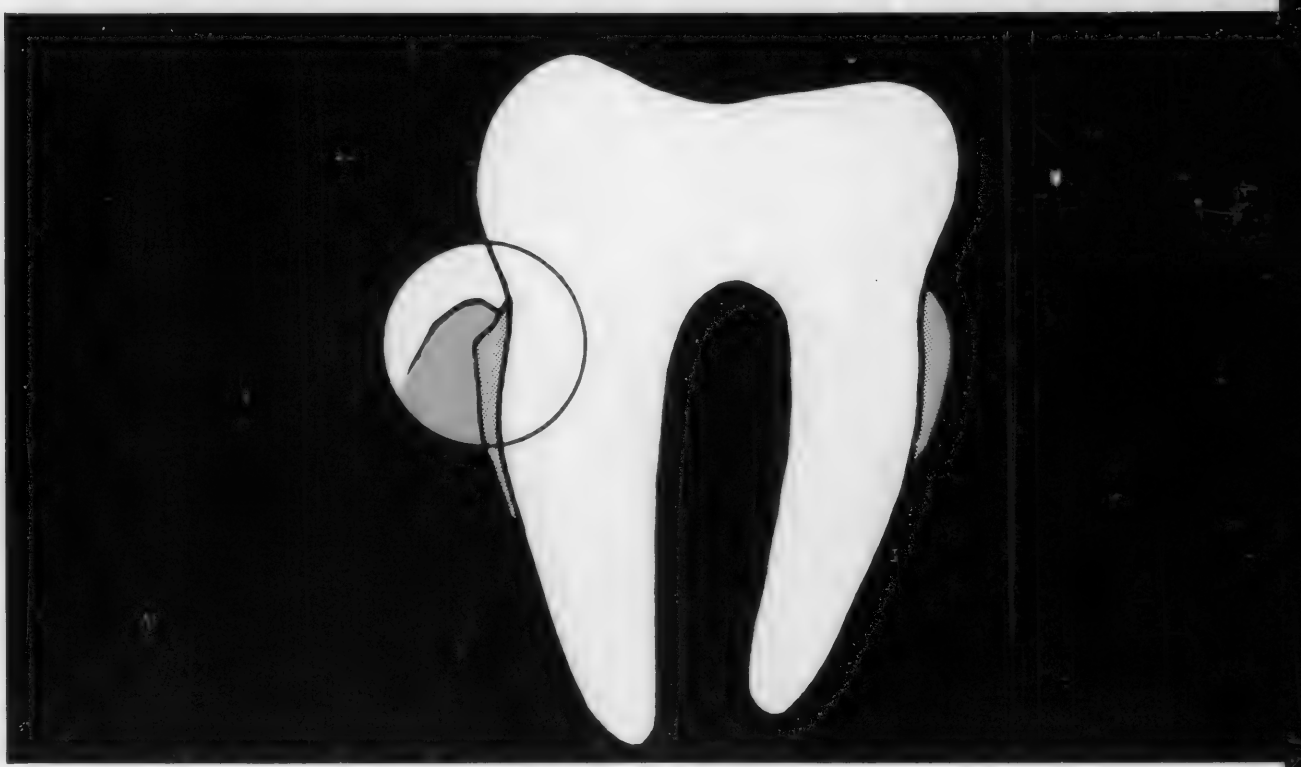

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Possible Roles of Diseased Cementum in Periodontitis

Peter J. Robinson, D.D.S., Ph.D.*

The role of cementum in periodontal disease remains in question despite extensive clinical and experimental study. In particular, the principal question remains whether cementum has any significance in periodontitis other than merely as a vehicle for calculus attachment. Recent evidence[1] indicates that cementum associated with periodontal disease undergoes morphological and biochemical changes that may contribute to the perpetuation of periodontitis. It is, therefore, important that this evidence and its implications be discussed.

Historically, therapists with one notable exception[7] have approached the role of cementum in periodontitis as an interface for calculus attachment. This is evidenced by the reference by many of the periodontology texts[5,6,8] to calculus removal as the principal rationale of root preparation (scaling and planing). Authors[2–4] have described root scaling and planing techniques in painstaking detail so the therapist would be insured of a calculus free, "glassy" smooth root surface. Yet, there is little experimental evidence that total calculus removal is paramount to periodontal health. The results of germ-free animal studies have suggested that calculus free of microbial invasion does not initiate periodontal disease.[21] Additionally, a recent report by Listgarten and Ellegaard observed electron microscope evidence of a cellular attachment between junctional epithelium and dental calculus in Rhesus monkeys.[14]

On the other hand, frequent reports have appeared in the literature implying that cemental changes are related to periodontal disease and are contributory to its pathogenesis. In order to clarify these implications, three areas of information must be discussed. First, what is the nature of the root changes? The second question is whether these cemental changes merely represent an unimportant result of periodontal breakdown or rather act as a stimulus to perpetuate periodontal disease. Finally, is the cementum able to cause cytotoxic changes on the surrounding gingiva directly or does it also act *via* humoral mediators of inflammation (*i.e.*, lymphotoxins liberated from sensitized lymphocytes)?

A number of reports as cited by Morris[15] have been made concerning the nature of the changes in cementum and the underlying dentin associated with periodontal disease. These include softer root surface,[16,17] removal of collagen,[23,29] diminution in the organic portion,[28] dissolution of the dentinocemental junction,[29] cemental splitting,[11] thinner layers,[12] more resorption,[10,22] demineralization[23] and hypermineralization.[24,25,28]

Even though there is variation between the findings of these reports, the important factor is the consistency with which deviations from the normal morphology of cementum were noted. Cementum is not static in periodontitis but rather demonstrates a wide range of pathologic changes. This wide range could, in part, be accounted for by accepting the concept that there are several variants of periodontitis associated with several different mechanisms of destruction. Also, the biochemistry of the changes in diseased cementum to date have not been reported. The biochemical description of these changes may, in the

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future, aid in clarifying the morphologic variations.

A fascinating finding by Aleo *et al.*[1] has stimulated thinking that the incorporation of bacterial products within cementum as well as cemental structural changes may contribute to the pathogenesis of periodontitis. Aleo detected endotoxin incorporated in cementum associated with periodontal pockets. This endotoxin was demonstrated to have a highly toxic effect in a cell culture system. Additionally, endotoxin has been demonstrated to reduce the rate of oxygen metabolism of cells and tissues that make up the periodontium (bone cells and fibroblasts of the periodontal ligament).[19] Thus, cementum free of calculus and plaque could perpetuate periodontitis by structural changes which would not allow normal attachment of connective tissue fibers to occur and by bacterial products within the cementum matrix interfering with the normal repair mechanisms.

To date, there is no conclusive clinical evidence that directly correlates these cemental changes with the progression of periodontitis. Yet, diseased human cementum has been reported to have toxic properties when tested in *in vivo* and *in vitro* laboratory systems. Hatfield and Baumhammer[9] described cytotoxic results on epithelium cultured *in vitro* with periodontally diseased roots. Additionally, Morris[15] implanted portions of human dental roots with bone subcutaneously in the dorsum of rats. Morris interpreted his findings as indicating that diseased roots inhibit bone growth, whereas healthy roots do not affect bone growth. The results from both of these groups of investigators are difficult to extrapolate to clinical periodontitis. A more acceptable system would have to include methods that can detect changes that occur within cementum and see if these changes reflect the degree or rate of the pathogenesis of periodontitis.

In addition to direct cytotoxic effects, diseased cementum may indirectly cause destruction of surrounding tissues by triggering immune mechanisms. These stimulated immune mechanisms may have cytotoxic potential by means of their mediators of inflammation. To date, little information has been reported on the antigenic potential of cementum. Robinson and Rowlands[18] have suggested on the basis of tooth transplantation studies that changes in the cementum of tooth grafts may account for the host's chronic inflammatory reaction which eventually results in loss of tooth transplants. This chronic non-specific response takes place even with genetically compatible teeth and in the case of replants. Since the organic phase of cementum has been characterized as essentially collagenous with a scant cell population[20] and there is morphologic evidence that cemental collagen changes are associated with periodontal disease,[23,29] it appears that one reasonable approach to determine the role of diseased cementum is to characterize its collagen immunologically. This approach is especially appropriate in light of recent evidence of elevated levels of collagen specific antibodies in patients with other chronic inflammatory diseases.[26]

The possible role of damaged cemental collagen is given additional significance by the findings of Kirrane and Glynn and others.[13,27] Enhanced immunogenicity of denatured collagen was reported by Kirrane and Glynn[13] and Steffin *et al.*[27] This finding lends support to Willoughby and DiRosa's hypothesis[30] on the role of damaged tissue in chronic inflammation. Willoughby and DiRosa have suggested that the immune response to diseased, damaged collagen (denatured) can perpetuate the cycle of chronic inflammation *in situ*. Those observations could account in part for the character of the lesion in periodontitis, as well as the great difficulty encountered in the therapeutic control of this chronic disease.

In summary, the distinct role of diseased cementum in the progression of periodontal disease is equivocal, yet there is strong evidence to indicate diseased cementum can cause cell and tissue damage. Several hypotheses have been presented to account for the cytotoxic capacity of diseased cementum: (1) Direct toxic effect by means of bacterial products incorporated within diseased roots; (2) Indirect effect of incorporated bacterial products by means of initiating a cytotoxic immune response; (3) Morphological and biochemical changes in the cementum interfering with the repair of normal connective tissue attachment; (4) Biochemical changes in the collagenous structure of cementum initiating an autoimmune response.

Even though it has been suggested that cementum's role in periodontitis extends far beyond merely a surface for calculus and plaque attachment, the importance of root scaling and planing is not diminished. Rather, these observations on diseased cementum underline the importance of instrumentation of the hard tissue wall (cementum) of a periodontal pocket as a preventive measure. The rationale of root scaling and planing should be looked upon as removal of diseased cementum as well as calculus removal in order to interfere with the perpetuation of periodontitis.

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Effects of Three Mouthwashes on Existing Dental Plaque Accumulations

Harold G. Carter, D.M.D., M.P.H.* and George P. Barnes, D.D.S., M.S.D.**

The importance of bacterial plaque as an etiologic factor in dental caries and periodontal disease is readily accepted throughout dentistry. Although the only effective means presently available to patients for the removal of plaque is *via* mechanical methods, several recent papers[1,3,8,10–12,15,17,20] have reported certain experimental chemical agents to be beneficial in preventing and reducing plaque accumulations on the teeth. Unfortunately, it appears that more research is needed in the evaluation of these agents, and it may be several years before a new chemical plaque inhibitor is available for use by patients. Accordingly, there have been some recent evaluations of commercially available mouthwashes to determine their potential for inhibiting plaque accumulation on the teeth. Gomer, *et al.*[9] and Lusk, *et al.*[13] reported that a commercial product containing essential oils (thymol and eucalyptol) significantly inhibited plaque formation. In the latter paper, the agent was reported to significantly reduce formed plaque deposits in addition to inhibiting new accumulations. Also Sturzenberger and Leonard,[19] as well as others,[2,6] reported a commercial product containing cetylpyridinium chloride and domiphen bromide to clinically reduce gingivitis and/or prevent plaque deposition. Ciancio, Mather and Bunnell[4] reported that another mouthwash containing only cetylpyridinium chloride significantly inhibited plaque accumulation. Since the subjects in the studies evaluating cetylpyridinium chloride containing products received initial prophylaxes, the results could be interpreted to determine the efficacy of the agents in preventing new plaque formation. It would be interesting to know the effect of these mouthwashes on existing plaque deposits.

The specific purpose of the investigations reported in this paper was to determine the clinical effects of three commercial mouthwashes (including one containing cetylpyridinium chloride) on existing plaque accumulations on the teeth. Since Cutright, *et al.*[5] found no ill effects to the mucosa or submucosa of animals to result from the use of 11 mouthwashes, it is possible that one or more of these three products might be useful as an adjunct in preventing dental disease.

METHODS

This study consisted of two parts. In Part I, a total of 65 male military personnel voluntarily consented to serve as subjects. They ranged in age from 18 to 43 years with a mean age of 24.2 years. Fifty-five subjects were Caucasians and the remainder were non-Caucasian.

Each subject underwent 2 examinations. The pretreatment examinations were performed on Day 1 (the day immediately preceding initiation of experimental procedures) and the posttreatment examinations were performed on Day 16 (the day following cessation of experimental procedures). All examinations were conducted by the same examiner, who was uninformed as to the composition of the groups and the experimental therapies received by the various subjects. The procedures used in conducting the examinations were as follows: the subjects were required to rinse their mouths for 60 seconds with 20 ml of a plaque disclosing solution (an aqueous solution of 3.0% basic fuchsin in ethanol). Following this, each subject was examined for bacterial plaque using the index described by Quigley and

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Hein.[14] The subjects were prohibited from performing any oral hygiene procedures immediately preceding their examinations.

Prior to initial examinations, the subjects had been randomly divided into 5 groups of 13 individuals each. Immediately following the initial examinations, the subjects were each issued a 14 day supply of mouthwash (or else no agent) according to the following schedule: Group A served as controls and received no mouthwash; Group B also served as controls and was issued colored, flavored water; Group C received a commercial mouthwash containing benzethonium chloride*; Group D received a commercial mouthwash containing essential oils (thymol and eucalyptol), methyl salicylate, benzoic acid, and boric acid,** and Group E received a commercial mouthwash containing cetylpyridinium chloride.*** Prior to issue, the mouthwashes were transferred to keep the subject and examiner uninformed. The subjects were instructed to rinse with 30 ml of their assigned mouthwash for 60 seconds. This procedure was performed twice daily during the 14 days between the initial and final examinations. Graduated cups were issued to the subjects in order to insure accurate measurement of the fluids. All subjects were instructed to continue their normal home oral hygiene procedures without change, except that mouthwashes other than as assigned were prohibited. During the study, the subjects were allowed to receive definitive dental treatment, with the exception of prophylaxes and scalings, which were specifically prohibited.

In Part II, 96 female military personnel volunteered to serve as subjects. They ranged in age from 18 to 40 years with a mean age of 22 years. A total of 78 subjects were Caucasians and the remainder were non-Caucasian.

As in Part I, each subject received two examinations to determine plaque accumulations. The examination procedures in the second part of the study were identical to those of Part I, with the exception that the final examinations were performed on Day 23 instead of Day 16. The examinations were conducted by the same examiner as in Part I.

Prior to receiving their initial examinations, the subjects had been randomly divided into three groups of 32 individuals each. Immediately following their initial examinations, the subjects were issued graduated measuring cups and a 21 day supply of mouthwash according to the following schedule: Group A received the cetylpyridinium chloride containing mouthwash; Group B received the benzethonium chloride mouthwash; and Group C served as controls and were issued colored flavored water.

The rinsing procedures used by the subjects in Part II were identical to those used by the Part I subjects, except that they rinsed with their assigned mouthwashes for a period of 21 days instead of 14 days. The subjects were instructed to continue their normal home oral hygiene procedures without change, except that mouthwashes other than as assigned were prohibited. During the study, the subjects were prohibited from receiving prophylaxes and scalings.

Upon completion of Part I, the initial examination and final examination mean plaque scores were tabulated for the subjects in each of the 5 groups. For each group incremental differences in mean plaque scores were calculated and the changes were expressed as percentages. All incremental differences within the groups and between the various groups were statistically analyzed using Dunnett's "*t*" test,[7] analysis of variance[16] and Scheffe's Method for Multiple Comparisons.[16] The same data tabulations and analyses were conducted using the plaque scores of the subjects in the three groups in Part II, when that investigation was completed.

RESULTS

Information concerning the changes in mean plaque scores for the subjects in the various groups in Parts I and II of the study are related in Tables 1 and 2, respectively. Each table relates information concerning the mouthwashes used by the various groups; the number of subjects in each group; the initial and final mean plaque scores for the groups; the incremental and percentage changes in plaque scores within the groups; and the

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* Colgate 100; Colgate-Palmolive Company, New York, NY.

** Listerine; Warner-Lambert Company, Morris Plains, NJ.

*** Cēpacol; Merrel-National Laboratories, Division of Richardson-Merrel, Inc., Cincinnati, OH.

Table 1. Effects of Various Mouthwashes on Existing Dental Plaque: Part I

Group	Mouthwash	Number Subjects	Mean Plaque Scores ± SD		Differences Within Groups		
			Initial	Final	Incremental	Percentage	P
A	None (Control)	12	1.51 ± 0.333	1.35 ± 0.305	−0.16	−10.6	NS
B	Flavored Water (Control)	9	1.14 ± 0.641	1.29 ± 0.804	+0.15	+11.6	NS
C	Benzethonium Chloride	13	1.49 ± 0.553	1.27 ± 0.655	−0.22	−14.8	NS
D	Essential Oils Methyl Salicylate	11	1.20 ± 0.467	1.10 ± 0.607	−0.10	− 8.3	NS
E	Cetylpyridinium Chloride	12	1.91 ± 0.624	1.46 ± 0.587	−0.45	−23.6	<0.02

Comparison of Differences Between Groups

Comparisons	P
Groups B vs E	<0.05
Groups A vs E	NS
Groups A and B vs C and D	All NS

statistical analysis of the incremental differences within and between groups.

In Part I, 8 subjects failed to complete the experimental procedures and in Part II, 24 subjects were unavailable for the final examination. Data is presented for only the 57 subjects completing Part I and the 72 subjects completing Part II.

DISCUSSION

In Part I of the study, the control group using no mouthwash demonstrated a slight, but not significant improvement in mean plaque scores. It is possible that this slight change was a result of the subjects being aware that they were participating in a dental evaluation. Since the subjects in both groups who rinsed with colored flavored water did not demonstrate significant changes in mean plaque scores, it appears that any plaque reductions resulting from the use of the other mouthwashes would be related to the chemical properties of the agents rather than a result of mechanical rinsing.

The finding of a very small non-significant plaque reduction following the use of the mouthwash containing essential oils, methyl salicylate, benzoic acid and boric acid in Part I of the present study is in contrast to the data reported by Lusk, *et al.*[13] Those workers reported a significant reduction in formed plaque resulting from the use of that mouthwash. Differences in the study designs might explain the contrasting data in these two investigations. The subjects in the previous investigation served as their own controls, while in the present study an experimental group was compared with a control group not using the test mouthwash. Also, the subjects in the earlier study were periodontists, whereas the present investigation used non-dental, non-medical personnel as subjects.

In both parts of the present investigation, use of only the mouthwash containing cetylpyridinium chloride resulted in significant reductions in existing plaque accumulations. Use of this agent resulted in a 23.6 per cent plaque reduction ($P < 0.02$) in Part I and a 24.8 per cent reduction ($P < 0.001$) in Part II. While the exact mechanisms of action of this mouthwash are in question, it has been suggested that cetylpyridinium chloride, in some manner, acts as an antibacterial agent.[18] In any event, the data from this investigation, as well as other studies[2,4,6,19] indicate that mouthwashes containing cetylpyridinium chloride might be useful as adjuncts in preventing plaque accumulation on the teeth. However, it should be emphasized that these mouthwashes are to be used in conjunction with, rather than in lieu of, conventional mechanical plaque control measures. Since both agents are quaternary ammonium compounds, it was interesting that use of the benzethonium chloride mouthwash was not as effective in reduc-

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[1] *Accepted Dental Therapeutics 1973/74*, 241-242
[2] Aasenden, R., and Peebles, T. C.: Effects of Fluoride Supplementation from Birth on Human Deciduous and Permanent Teeth. *Archs. Oral Biol 19*:321-326, 1974
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Table 2. Effects of Two Mouthwashes on Existing Dental Plaque: Part II

Group	Mouthwash	Number Subjects	Mean Plaque Scores ± SD		Differences Within Groups		
			Initial	Final	Incremental	Percentage	P
A	Cetylpyridinium Chloride	25	1.33 ± 0.581	1.00 ± 0.516	−0.33	−24.8	<0.001
B	Benzethonium Chloride	25	1.27 ± 0.610	1.29 ± 0.612	+0.02	+ 1.6	NS
C	Flavored Water (Control)	22	1.39 ± 0.605	1.50 ± 0.521	+0.11	+ 7.3	NS

Comparison of Differences Between Groups

Comparisons	P
Groups A vs B	<0.01
Groups A vs C	<0.001
Groups B vs C	NS

ing existing plaque deposits as was the cetylpyridinium chloride mouthwash.

The findings in this investigation prompt some questions. At least two cetylpyridinium chloride-containing mouthwashes have been reported to have plaque inhibitory effects.[2,4,6,19] From the practical point of view of unsupervised patient use, is it possible that one of these products may be more effective than the other, due to patients' preferences as to taste and other properties? Since mouthwashes containing cetylpyridinium chloride have demonstrated plaque inhibitory effects, is it possible that commercially available lozenges and/or other vehicles containing this agent might have similar effects? Further studies are indicated.

SUMMARY

The specific purpose of this double blind clinical study was to determine the effects of several mouthwashes on existing plaque accumulations. The investigation consisted of two parts. The 57 adult subjects completing Part I were randomly divided into five groups. For two weeks Group A served as controls and received no mouthwash; Group B (also controls) rinsed with colored flavored water; Group C rinsed with a commercial mouthwash containing benzethonium chloride; Group D rinsed with a commercial mouthwash containing essential oils, methyl salicylate, benzoic acid, and boric acid; and Group E rinsed with a commercial mouthwash containing cetylpyridinium chloride. The 72 subjects completing Part II were randomly divided into three groups. For three weeks, Group A rinsed with the cetylpyridinium chloride mouthwash; Group B rinsed with the benzethonium chloride mouthwash; and Group C served as controls and rinsed with colored flavored water. During the investigation, dental prophylaxes and use of mouthwashes other than as assigned were specifically prohibited. In both study parts, the subjects received the same pre-test, post-test examinations to determine their plaque scores.

During both parts of the study, the subjects rinsing with the cetylpyridinium chloride mouthwash experienced significant reductions in mean plaque scores. The improvements were significant within and between groups. Under the conditions of this experiment, use of the other mouthwashes did not result in significant reductions in existing plaque accumulations.

Based upon the data obtained, the daily use of a commercial mouthwash containing cetylpyridinium chloride appears to be partially effective in reducing bacterial plaque accumulations. The plaque reductions resulting from the use of this mouthwash seem to be related to its chemical properties rather than to the mechanical act of rinsing. While use of a cetylpyridinium chloride mouthwash, in conjunction with normal mechanical plaque control measures, might be beneficial to patients, further long-term clinical studies are

needed to determine if the reductions noted in disclosed plaque provide similar reductions in dental diseases affecting the gingival margin and enamel surface.

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Comparison of Dentists' Attitudes and Task Delegation Patterns

Marvin Marcus, D.D.S., M.P.H.*

An important issue in the subject of dental auxiliary use concerns the implementation of task reallocation at the practice level. There are four stages in the process of change toward expanded roles for dental auxiliaries. First, the legal barriers to delegation must be lifted through revisions of state dental practice acts. The second stage concerns the attitudinal change of dentists toward transfer of tasks to auxiliaries. The third stage involves the training of auxiliaries in expanded functions, and implementation of task reallocation in the delivery of care. The fourth and final stage is achieved when the levels of task delegation in a practice are appropriate to its functioning.

The Washington State Dental Practice Act[3] was revised in 1971 to permit auxiliaries certain expanded functions. Six months after the revision, Koerner and Osterholt[1] conducted an attitudinal survey of Washington dentists. Fifty-five per cent of the dentist population responded to a questionnaire concerning their attitudes toward the reallocation of certain tasks to dental hygienists and dental assistants. Although the response rate was not sufficient to profile the entire dentist population of Washington, it provided an indication of the second stage in the changing use of auxiliary personnel, and of further potential delegation.

From October 1973 to September 1974, the patterns of task delegation** were obtained and studied during consecutive 4 week data collection periods for each of 18 private practices in Washington. The Task Analysis dental information system (UCLA)[2] was used to collect this baseline data from dental practices which intended to participate in the Mobile-In-Service Training Unit (MIT), a program conducted by the University of Washington* designed to teach expanded functions to practicing auxiliaries. This baseline data is also to be used in conducting partial evaluations of the MIT program. The data collected indicate the degree to which task reallocation has been implemented two years after the revision of the state dental practice act. Most of these practices are between the second and third stages of task reallocation.

This paper compares the attitudinal survey of Washington dentists (991) to actual task delegation patterns in the 18 private practices** with regard to 7 comparable tasks performed during the task analysis study period.

METHOD

In order to determine the differences between the attitudes of Washington dentists toward task reallocation 6 months after the revision of the state dental practice act, and the delegation patterns in 18 practices two years later, the dentist population in Koerner's study had to be made comparable to the age distribution of the Task Analysis dentists. This was achieved by a weighted average based on the ages of the 20 dentists. Seven comparable tasks were identified between the two studies. These tasks are: 1. bitewing X-rays; 2. fluoride treatment; 3. place rubber dam; 4. administer anesthetic; 5. fill and

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"Task Analysis in Dentistry: Computer Applications." Research supported by the Health Resources Administration, Office of Special Programs; Grant Number 1R27 MB 001801 S1.

From the International Association of Dental Research.

** Data available upon request.

* The University of Washington was awarded a contract in September 1972 by HEW (NIH Bureau of Health Manpower Education). Three main priorities were identified: (1) to educate auxiliary educators to teach expanded functions; (2) to provide equipment and facilities; and (3) to assist auxiliary training schools in the training of students, and to provide instruction for practicing auxiliaries. This program was coordinated by the University of Washington Dental School through the Department of Continuing Education.

** The personnel in the 18 private practices consists of 20 dentists, 13 dental hygienists, 43 dental assistants, and 19 receptionists.

carve restorations; 6. patient education, and 7. polish filled restorations.

The percentage of affirmative responses in Koerner's study and the Task Analysis delegation patterns are compared to indicate the difference, if any, between the attitudinal stage and the implementation stage. It is noted that both samples have some bias. There is only a 55 per cent response rate in Koerner's study, and the Task Analysis practices are self-selected with regard to their interest in auxiliary use. The value of comparing these studies is to gain insight into the relationship between dentists' attitudes and the implementation of task reallocation. The hypothesis that there is no difference between attitude and actual delegation is tested by means of the Fisher's Exact test at a $P < 0.05$ level of significance.

FINDINGS

Table 1 presents the results of the comparison of 7 tasks based upon the percentage of affirmative responses in the attitudinal survey as compared to the percentage of practices that actually delegated tasks to either dental hygienists or dental assistants in the Task Analysis study.

1. Bitewing X-ray. There was a statistically significant difference between attitude and implementation indicated for the dental hygienist. The direction of this difference is toward less actual delegation. With regard to the dental assistant, there was no difference observed between attitude and delegation.

2. Fluoride Treatment. In 12 of the 18 practices which performed this task to any extent,* no significant difference was found between attitude and actual delegation for the dental hygienist. With respect to the dental assistant, however, there was significantly less delegation than indicated in Koerner's survey.

3. Place Rubber Dam. Although the attitude toward delegation of this task to the hygienist was relatively positive (75%), only 16.7 per cent of the Task Analysis practices actually used this auxiliary. On the other hand, the attitude and the delegation patterns coincided with regard to the dental assistant's involvement in rubber dam placement.

Table 1. Comparison of Washington Dentists' Attitudes with Patterns of Delegation in Task Analysis Practices: 7 Tasks.

Task	Provider	Koerner % Affirmative (910 Dentists)*	T.A. Practices % Performed	Number of Practices
Bitewing X-ray	Hygienist	93.0	66.7**	12
	Assistant	94.0	94.4	18
Fluoride Treatment	Hygienist	94.0	55.9	9
	Assistant	86.0	66.7**	12
Place Rubber Dam	Hygienist	75.0	16.7**	12
	Assistant	70.0	77.8	18
Administer Anesthetic	Hygienist	39.0	41.7	12
Fill & Carve Restorations	Hygienist	36.0	16.7	12
Patient Education	Assistant	95.0	81.3**	16
Polish Filled Restorations	Assistant	58.0	62.5	8

* Standardized for comparable age of Task Analysis Dentists.
** A statistically significant difference at the $P < 0.05$ level.

4. Administer Anesthetic. There was no significant difference between the two studies with respect to the dental hygienist. This task is an indicator of the changing role of the dental hygienist, and the willingness of the dentist to delegate. The dental assistant is not permitted by state law to perform this task.

5. Fill and Carve Restorations. In Washington, this task can legally be performed by a dental hygienist. There was no significant difference between attitude and actual delegation of this task to the dental hygienist in the 12 practices which employed this auxiliary.

6. Patient Education. The role of the dental assistant in patient education was significantly different from the dentists' highly positive attitude toward delegating this task.

7. Polish Filled Restorations. Only 8 practices performed this task to any extent.* There was no significant difference between attitude and actual delegation with respect to the assistant's involvement in this task.

DISCUSSION

In the arena of task delegation, there is an interplay between the dental hygienist and the dental assistant. In the case of Bitewing X-ray, both auxiliaries have traditionally performed this

* Performed 10 or more times during the 4 week data collection period.

* Performed 10 or more times during the 4 week data collection period.

task. There was no difference between attitude and implementation for the dental assistant indicated in the comparison. The dental hygienist, however, was performing significantly less Bitewing X-rays than the attitudinal survey suggests. It appears that this task is firmly placed in the dental assistant's repertoire. The dental hygienist seems to be deferring to the assistant with respect to this task.

Fluoride treatment is traditionally performed by the hygienist. This is confirmed in terms of attitude and implementation. In Washington, the dental assistant has recently been allowed to perform fluoride treatments. The comparison indicates that although this task is delegated to the dental assistant to a considerable degree, there remains a significant difference between attitude and implementation at this point in time. However, the trend indicates that increased involvement of the dental assistant in this task can be expected in the future. A limiting factor may be the dental hygienist's desire to maintain control of this task. Perhaps as these practices approach stage four, a point will be reached where one or the other auxiliary will predominantly perform fluoride treatments. At this point in time, however, the dental hygienist still maintains the dominant position. Rubber dam placement is of interest because it is a task which did not traditionally belong to either auxiliary. Although a positive attitude toward participation of both auxiliaries was indicated, actual delegation of this task to the dental hygienist was significantly less than suggested. In only 16.7 per cent of the practices that employed dental hygienists did they perform this task. On the other hand, dental assistants performed this task in 77.8 per cent. In their case, no significant difference between attitude and implementation was found. Rubber dam placement seems to be a task which can functionally be delegated to the dental assistant.

Administering anesthetics and filling and carving dental restorations are tasks that were not delegated in Washington until the 1971 revision of the dental practice act. It is now possible for dental hygienists to perform these tasks. In Koerner's study, 39.0 per cent of the dentists said they would permit dental hygienists to administer local anesthetics. In 41.7 per cent of the Task Analysis practices dental hygienists performed this task. There is no significant difference between attitude and implementation in this case. It is important, however, to emphasize that delegation did in fact occur. There was less delegation of filling and carving dental restorations to the dental hygienist than administering anesthetics. Only 16.7 per cent of the T.A. practices allowed the dental hygienist to perform this task. The response to the attitudinal survey was 36.0 per cent. Although this is not a significant difference, it seems that the dental hygienist's role in restorative tasks in these Washington practices has yet to be clearly defined. Perhaps, as more continuing education becomes available to practicing dental hygienists, and new graduates enter the profession, more delegation of this task will be observed.

Delegation to the dental assistant of patient education, and polishing filled restorations had different outcomes. Ninety-five per cent of the dentists surveyed would permit the dental assistant to provide patient education. This highly positive attitude was not reached in the practices studied. Most of the practices (81.3%) did permit the assistant to perform this task. However, a statistically significant difference was found between attitude and implementation which indicates that although this attitude was almost universally held (95.0%), it has yet to be translated into actual delegation. The other assistant task, polishing filled restorations, was only performed in 8 of the 18 practices. Of these, 62.5 per cent permitted the assistant to polish restorations. There was no significant difference between attitude and implementation. With so few practices performing this task, it can only be noted that delegation to the assistant did occur.

SUMMARY

Once the legal barriers to task reallocation are lifted, a positive attitude on the part of dentists is necessary so that task transfer may take place. The final stage in task allocation is reached when the patterns achieved correspond to the overall needs of the practice. Prior to this, there is a transitional stage between positive attitude and actual implementation. This phase is studied in

the comparison of Washington dentists' attitudes to actual task delegation patterns in 18 private Washington practices. This comparison of 7 delegable tasks provides some indication of the differential between affirmative attitude and actual task delegation.

Significant differences between attitude and implementation were found at the $P < 0.05$ level for the dental hygienist with regard to *Bitewing X-ray* and *Rubber Dam Placement*. It appears that the dental hygienist is not actively participating in either task. *Fluoride Treatment* remains a hygienist task although the assistant may legally perform it. While dentists were positively disposed toward delegation of these tasks, their attitude toward the dental hygienist performing *Administer Anesthetic* and *Fill and Carve Restoration* was not nearly as positive. The implementation phase was consistent with the attitude indicated. More practices did permit the dental hygienist to *Administer Anesthetics* than to perform *Fill and Carve Restorations*. This could reflect the hygienist's reluctance to perform these tasks without receiving additional training such as that provided by the MIT program.

The dental assistant seems to be meeting the expressed attitude for an expanded role in the Washington practices surveyed. *Rubber Dam Placements* and *Bitewing X-rays* are a firm part of the dental assistant's role. The dentists' attitudes indicated with respect to the dental assistant's performing *Fluoride Treatments* and *Patient Education* were higher than the actual implementation level. *Polish Filled Restorations* was not performed by enough practices to provide insight into this transition.

The continuous process of change in the increased use of dental auxiliary personnel in the delivery of care should be measured at various points in the continuum. This comparison of attitude *versus* actual reallocation points to the need for continued study of this process. In this way, the profession can better understand the factors which influence the stages of change in auxiliary use at the practice level.

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In all our estimates of antidotes
To fell disease in every hateful form,
The sound condition of the *dental arch*
Stands prominent. The teeth so highly priz'd
In nature's schemes of growth and nutriment,
Are *twice produced* in mercy to our race,
To give protection and stability
To those essential organs:—and the food
Ere deglution hurries it along
To the digestive powers, must be prepared
By mastication for its final use.

And they are more. The beauty of the face,
The part we wish mankind to know us by,
Where speak the moving passions of the soul,
Is quite disfigured if the teeth be bad.
But when in shining ranks of polish'd pearls
Untarnished by disease, they lend a grace
E'en to the plainest features, which not all
The jewels of the Indies could impart.
Besides, they greatly modify the speech,
One of the noblest attributes of man;
And give to vocal music half its charm.

From "Dental Hygeia, A Poem", by Solyman Brown, A.M.—published in 1838.

The Continuing Vitamin C Controversy

Patricia Randolph, B.S., M.S.*

Every year millions of Americans suffer from the common cold. They eagerly anticipate a cure-all and are willing to try almost anything that sounds reasonable if there is a chance of reducing their susceptibility. In 1970, Dr. Linus Pauling[30] suggested that supplemental vitamin C taken daily in large doses (gram amounts) would reduce the individual's susceptibility. This was in contrast to the recommendation of the Food and Nutrition Board of the National Research Council[26] which stated that the level of daily intake should be in milligram amounts.

An early study by Glazebrook and Thomson[17] explored the relationship of vitamin C and occurrence of the common cold. They were unable to find an association. Little interest developed until Dr. Pauling's book[30] was released. The book was widely read and public awareness was renewed. Medical and dental practitioners began to be inundated with questions concerning the value of vitamin C.

The scientific community became divided regarding the validity of the supplemental use of vitamin C either as a therapeutic or prophylactic agent. Dr. Pauling has received support for some of his recommendations. Wilson and Loh[39] indicated that two grams of vitamin C daily could have a prophylactic effect in 80 to 90 per cent of the population. Reviewing their work, they[40] offered partial explanation for the results. Suggested roles assigned to the vitamin included enhancement of phagocytosis, antigen-antibody response and promotion of tissue healing.

Anderson, Reid, and Beaton[1] reported that a group receiving supplemental vitamin C had fewer days of illness during their study than the control group. Using one gram supplementation daily, they were unable to substantiate all the claims made by Dr. Pauling. However, the possibility that large intakes exerted either a specific antiviral or antibacterial effect or produced a mechanism of a more general nature was posed. The authors indicated that their data could not answer the question but suggested that, since general rather than local symptoms seemed to be the most influenced, it would appear the mechanism was nonspecific.

Coulehan, Reisinger, Rogers and Bradley[11] noted no difference in the number of respiratory infections in a control group receiving a placebo and a group receiving one and two grams of supplemental vitamin C daily. However, the authors observed that the group receiving supplementation had less sick days reported during the survey. In this study, blood levels of vitamin C rose in the groups supplemented but there was no significant difference between the group receiving one and two grams daily. Anderson, Suranyi and Beaton[2] suggested prophylactic doses of the vitamin alone had little effect on winter illness and their data did not support the views of Dr. Pauling. Indicating optimum intake of the vitamin to be less than 250 milligrams daily, the authors warned the public against daily intake of one gram or more. However, they suggest that supplementation of some diets during acute infections or times of stress may be warranted.

Others have expressed opinions in support of Dr. Pauling. Lee[24] has suggested the need for a three-year study involving 5 thousand subjects to refute or verify Pauling's statements. Enloe[14] and Butterworth[5] have commented on Dr. Pauling's approach to an age old problem, the common cold.

Some authors have presented opinions contrary to the reports previously mentioned. Kinlen and Peto[22] when commenting on the work of Wilson *et al.*,[39] stated that "in our opinion, their data are more satisfactorily explained if vitamin C is wholly without effect on the frequency or severity of colds." Passmore[29] pointed to a higher recommended daily allowance for the American than the British population. He suggested that there is no epidemiological evi-

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dence to support less colds in populations on lower vitamin C intake.

BENEFIT OR RISK?

Regardless of the role of vitamin C in the common cold, dental literature is replete with articles both in support and condemnation of the use of vitamin C in oral health and disease. Although Ringsdorf and Cheraskin[36] stated that multiple vitamin supplementation was beneficial to patients with gingivitis, they measured only the vitamin C in plasma and disregarded any possible effect of the other vitamins involved. Parfitt and Speirs[28] reported that supplemental vitamin C was not beneficial to the treatment of periodontal disease. And so today, the vitamin C controversy continues.

Despite the role of vitamin C supplementation in dental health or disease, another matter worthy of consideration has appeared with increasing frequency in medical and nutritional literature in the past three years. The question is possible toxicity. Goldsmith[18] pointed out that one gram per day may cause diarrhea. A Russian study[23] indicated 6 grams of vitamin C daily induced menstrual type bleeding in 16 of 20 pregnant women studied. A Massachusetts physician[38] reported that vitamin C is antagonistic to warfarin therapy. Morin[25] suggested that the rise in serum cholesterol levels observed in some patients suffering from atherosclerosis and receiving one gram of vitamin C daily could aggrevate the atherosclerotic condition. Finsten[15] stated that one physiological effect of massive doses of vitamin C is diuresis and possible dehydration after repeated daily overdosage.

Other literature has suggested that high level vitamin C supplementation may lead to tissue dependency. Cochrane[10] indicated that scurvy was more prevalent in a small group of infants born to mothers receiving prenatal conditioning with vitamin C even though the infant diet was adequate in the vitamin.

Two case histories of individuals deserve attention.[33] One individual developed scurvy when returning to a normal dietary intake two years after ingesting one gram of vitamin C a day for a year. Another individual working in the citrus groves of Florida drank excessive amounts of orange juice for several years. Returning to a more normal intake, he too developed symptoms of scurvy.

Scurvy is not common in this country but the disease has been widely studied. Crandon, Lund and Dill[12] have demonstrated that the vitamin C content of plasma or serum reflected within limits the dietary intake of the vitamin. However, absence of the vitamin from plasma did not permit one to predict tissue stores. The concentration of vitamin C approached zero in plasma some weeks prior to the appearance of clinically detectable lesions of scurvy. Based on the work of Crandon *et al.*,[12] Rinehart and Greenberg[34] and Oliveira, Pearson and Darby,[27] using a tissue saturation or tolerance test, demonstrated that the vitamin C stores of an individual could be reliably assessed. In human subjects suffering from induced scurvy, plasma levels of vitamin C remained above the level indicating deficiency according to a study reported by Hodges, *et al.*[20] They further stated poor correlation between plasma levels and total available vitamin C. These studies would indicate that plasma levels of vitamin C used alone are of little significance in assessing actual vitamin C tissue saturation levels.

LINGUAL VITAMIN C TEST

Although dentists have expressed their interest in the use of vitamin C as a therapeutic agent, most dental offices are not prepared to do extensive laboratory evaluation. If vitamin C deficiencies are to be detected and treated, a simple, reliable, reproducible test requiring little in the way of equipment and skill would be useful. When the lingual vitamin C test was introduced,[16] it was hoped that the test could meet these criteria and be carefully evaluated regarding its place in the treatment of dental patients. However, the lingual vitamin C test itself is not without controversy. The procedure is simple. A drop of blue dye (2,6 dichlorophenolendophenol) is placed on the tongue. Cheraskin and Ringsdorf[8,9,35,37] indicated a relationship between the lingual test time and plasma level of vitamin C. However, Randolph, Wilson, Roth, and Young[32] were unable to find a correlation between the lingual test time and serum level

or tissue level of vitamin C. Ault, Shannon, and Wescott[3] were unable to find a correlation between the lingual test time and blood concentration or the rate of urine excretion of vitamin C. Bright and Shannon[4] reported no significant correlation between lingual test time, whole blood concentration, urinary excretion or dietary intake of vitamin C.

The lingual vitamin C test has also been challenged in other areas. Cheraskin and Ringsdorf[7] have reported the test to be reproducible by one examiner. Eberhart, Randolph, Wilson, Roth and Young[13] found reproducibility of the lingual test between two independent examiners to be unsatisfactory. King and Little[21] noted that scrapings from the coating of the tongue and concentration of the dye may influence the test time. It is becoming increasingly evident that the lingual vitamin C test has not met the necessary criteria in the treatment of dental patients.

QUESTION OF QUANTITY

If it has been established that a deficiency does exist, how much vitamin C should be suggested? In some instances, supplemental vitamin C in grams is being prescribed. Cheraskin[6] stated that evidence indicated that a significant sector of the American population is malnourished and megavitamin therapy may offer a solution. He further stated that "there is some evidence that vitamin C deficiency is one of the common shortcomings in the American diet." On the contrary, the Ten State Nutrition Survey[19] reported vitamin C nutriture was not a major problem in the large population studied. Preliminary data from the first Health and Nutrition Survey[31] indicated that all age groups had vitamin C intake which was 90 to 100 per cent or above the standard.

Meanwhile the new Recommended Dietary Allowances (RDA) from the National Research Council have been released. These quantitative figures are amounts recommended for population groups and include a 30 to 50 per cent margin of safety. The values are revised every 5 years. The current revision (1974) has decreased the recommendation for daily intake of vitamin C for adults. In 1968, the RDA was 60 milligrams for men and 55 milligrams for women daily. The 1974 revision recommended 45 milligrams daily for adult males and females.

Since controversy surrounds the amount of vitamin C needed for optimum health, it seems pertinent to ask several questions of the dental practitioner. Is the recommendation of supplemental vitamin C scientifically sound without careful consideration of dietary intake? Is the recommendation of supplemental vitamin C at a level of one gram or above safe? How many dental offices are equipped to measure tissue levels of vitamin C? Can these offices promise (at the present knowledge level) that dental health will be enhanced or dental disease alleviated? When does a vitamin cease to be a vitamin and become a drug?

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American Dental Association
Bureau of Public Information

Chicago—Dentistry as a profession is becoming more attractive to women, according to the 1974–75 *Annual Report on Dental Education.*

Until recently, less than 2 per cent of the students entering U.S. dental schools have been women. Times are changing, however, and the number of women enrolling in the nation's 58 dental schools is steadily increasing.

Across the country this year, women dental students account for 11.2 per cent of the first-year class. This is comparable to a 3.2 per cent female enrollment in the fourth-year class.

In all, there are 1,361 women (6.8 per cent) within the nation's total dental school enrollment of 20,146. The total percentage of women students enrolled in dental schools increased by 2.5 per cent this year over the 1973–74 enrollment.

The report which is prepared by the American Dental Association's Council on Dental Education and the American Association of Dental Schools stated further: "Since nearly half of the women currently enrolled in dental schools are first-year students, it can be expected that the number of women dental students will continue to rise in the coming year."

Effects of Povidone-iodine and Isotonic Saline on the Oral Health of Children

L. F. Duany, R. J. Fitzgerald, M. Llorente and D. D. Zinner

An antibacterial mouthrinse which inhibits the microorganisms responsible for dental plaque formation, or prevents their attachment to the surfaces of the teeth or gingivae, could be a valuable aid in the prevention of caries and periodontal disease. Betadine, an antimicrobial iodine containing mouthwash, has demonstrated significant effectiveness in reducing gingival bacteria counts both after rinsing and after prophylaxis,[2] as well as in lowering the incidence of gingivectomy related bacteremia,[7] when compared to control groups. Another iodine solution applied to the teeth of children was able to keep half of the surfaces, which formerly harbored *S. mutans*, free of detectable proportions of the organisms for at least 13 weeks.[4]

A non-bactericidal dental anti-plaque agent which, in conjunction with routine oral hygiene, significantly reduces extent of plaque accumulation may improve the oral health of subjects without markedly altering the oral microflora. In a short-term clinical trial testing the efficacy of GK-101, an anti-plaque compound, the plaque of subjects rinsing with a placebo saline solution and the test solution was found to be considerably reduced.[9] Because of these findings a new redesigned pilot study was carried out with the same groups of children in order to determine the effect of two non-bactericidal saline mouthrinses in reducing extent of plaque and gingivitis. After prophylaxis with a calibrated electric toothbrush procedure, children in the isotonic saline group exhibited significantly less extent of plaque than those rinsing with deionized water.[3]

In view of these promising short-term results, it was thought appropriate to test these solutions on a long-term basis to obtain additional efficacy data in humans. In this program the use of mouthrinses and supervised toothbrushing may induce changes in the oral flora; such changes may correlate with clinical findings. Thus, microbiologic recordings on a subset of 68 study subjects were carried out.

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This study was supported in part by N.I.H. Grant No. P01 DE-02552-08. The Betadine mouthwash and control solution was provided by the Purdue Frederick Company, Norwalk, Connecticut.

This paper was presented in part at the 53rd General Meeting of the International Association for Dental Research, New York City, New York, April 8, 1975.

MATERIALS AND METHODS

A. *Study subjects*—Four hundred and sixty-eight children, ages six to fourteen (grades 2 through 5) attending the Ros Benitez elementary school in Caguas, Puerto Rico, were stratified by age and sex and previous caries experience. The initial mean age of the four study groups was the same; 9.0 years. Those children whose parents gave permission for participation were randomly assigned to four study groups:

1. Betadine mouthwash containing 0.5 per cent povidone-iodine and 8 per cent alcohol.
2. Control solution containing 8 per cent alcohol and matching the test solution in color.
3. Isotonic saline—one liter of deionized water, 8.5 grams of sodium chloride (99.5% pure NaCl crystals, J. T. Baker Chemical Co., Phillipsburg, N.J.) and a vanilla flavoring agent.
4. Deionized water with a vanilla flavoring agent. (Continental Deionized Water Service, U.S. Patent 3,190,320, Miami, Florida).

B. *Procedure*. Under the supervision of three dental assistants at the school site, each child performed the following routine three times a week during the school year:

Groups I and II

1. Brush teeth with a dry toothbrush (oral B20-children) for one minute

Table 1. Means and Standard Deviations for DMFS, Gingivitis and Extent of Plaque, August, 1973.

Group	N	DMFS		Gingivitis		Plaque	
		$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
I Betadine	119	2.98	4.79	0.29	0.47	1.51	1.64
II Betadine-placebo	120	3.92	5.24	0.49	0.71	1.66	1.80
III Isotonic saline	118	2.77	3.70	0.32	0.53	1.52	1.66
IV Deionized water	111	3.15	5.54	0.30	0.49	1.44	1.56
Totals	468						

Initial DMFS and plaque means are not significantly different. An analysis of variance among groups revealed the F test for gingivitis averages to be significant at the .01 level. Group II was significantly higher.

. . . all four quadrants, occlusal, buccal and lingual surfaces.

2. Rinse for 30 seconds with 7.5 ml of assigned solution. Expectorate into one of two zinc troughs specially built and installed for the program. The dimensions of the troughs were: 12 feet long, 1 foot wide, 1 foot deep with a 2 feet high protective backstop. The two conduits were placed on top of 1½ foot high wooden frames. During the brushing and rinsing procedure there was a constant stream of running water through the receptacles.
3. Repeat 30 second rinse with a second 7.5 ml of the assigned solution. Expectorate.

Groups III and IV

1. Same as Groups I and II except brushing of teeth was performed following the two mouthrinses.

The reason for having Group I children brush prior to rinsing was to allow for the physical disruption of plaque on different tooth surfaces, thereby promoting the antimicrobial action of the povidone-iodine solution. By contrast the saline treated group brushed after rinsing. The rationale for this procedure is based on two short-term clinical studies in which we observed an alteration in plaque adhesion when NaCl was used as a mouthwash.

C. *Dental Examination*. Children were examined in August and May of the school year, by the same examiner, without reference to the previous examination results. During the clinical examination the caries status of each tooth surface was recorded[8] on a specially designed optical-scan mark sense form. These entries were made by the same recorder.

Following clinical examinations, two bite-wing radiographs were taken of each child, using standardized techniques of exposure and auto-development. Radiographic findings were added to the clinical examination forms. Gingivitis was evaluated at each examination, using the gingival portion of the Periodontal Index.[5] After rinsing for 1 minute with a disclosing solution containing 0.5 per cent Fast Green (FDC #3 Green) extent of buccal plaque accumulation was assessed on all teeth using a plaque index which ranged from zero to four.[1]

D. *Procedure for Plaque Samples*. Prior to and at intervals during the study all plaque was removed from the occlusal surface of a non-carious randomly selected first permanent molar with a specially constructed sterile steel excavator. The instrument was designed so that it could be detached from the handle and dropped along with the plaque sample into a screw-capped vial containing 4.0 ml of transport medium[6] and approximately 20

Table 2. DMF Surfaces Net Increment*

Group	N	$\bar{X}$	S.D.
I–Betadine	104	.619	1.918
II–Betadine-placebo	114	.708	1.999
III–Isotonic saline	110	1.006	1.781
IV–Deionized water	108	.727	2.222
Totals	436		

An analysis of variance for group means did not detect any significant difference.

* Rosa Benitez School, Caguas, Puerto Rico, all subjects, August, 1973–May, 1974, Clinical and X-ray examinations.

Table 3. Mean Differences for Gingivitis.*

Group	N	Aug-73	May-74	Difference	% Reduction	P
I Betadine	104	0.29	0.18	−0.11	37.9	<0.02
II Betadine-placebo	114	0.49	0.32	−0.17	34.6	<0.01
III Isotonic saline	110	0.32	0.19	−0.13	40.6	<0.01
IV Deionized water	108	0.30	0.20	−0.10	33.3	<0.06
Totals	436					

Analysis of variance for May gingivitis average scores showed a significant difference at the 5% level.
* Rosa Benitez School, Caguas, Puerto Rico, all subjects, August, 1973–May, 1974.

glass spheres 1 mm in diameter. The vials were transferred at ambient temperature to the laboratory in Miami and all samples were processed for plating within 48 hours after collection.

The plaque was dispersed by shaking for two minutes on the high setting of a Vortex Mixer and tenfold serial dilutions were made in 0.5 per cent yeast extract solution. Aliquots of 1.0 ml were spread on the surface of Mitis-Salivarius Agar plates and the plates were incubated 24 hours at 35 C in an atmosphere of 90 per cent nitrogen-10 per cent carbon dioxide. They were then incubated for an additional 24 hours in air at room temperature and differential streptococcal counts were performed. The streptococci were grouped on the basis of colony morphology into the following categories: *Streptococcus mutans*, *Streptococcus sanguis*, *Streptococcus salivarius* and other streptococci.[6] The differential counts were expressed as a percentage of the total streptococcal colony forming units for the sample. Because the plaque was not weighed, the total streptococcal count for each sample was also recorded in order to obtain an estimate of the amount of plaque which was present in the sample.

RESULTS

Of the initial 468 children in August, 1973, 436 students were examined at the completion of the first year of the program, a 6.8 per cent attrition rate.

The initial dental status of the population studies is shown in Table 1. No significant differences among group means of DMFS, or plaque scores were detected. However, an analysis of variance among gingivitis group means revealed a significant difference at the .01 level. Group II average was significantly higher. No significant differences among baseline group means of total streptococcal colony counts, or per cent of *Streptococcus mutans*, *Streptococcus sanguis*, and other streptococci (Tables 5, 6, 7 and 9) were observed. The per cent of *Streptococcus salivarius* was significantly higher, at the onset of the study, in the deionized water group of children (Table 8).

DMFS net increments are summarized in Table 2. At the end of the school year differences among the net DMFS increments of the betadine, betadine-placebo, isotonic saline and deionized water groups, 0.619, 0.708, 1.006, and 0.727 respectively, were not statistically significant.

Over the school year the mean change in the gingivitis score (Table 3) for Group II (alcohol-placebo) was found to be significantly higher than the combined means for Groups I, III and IV ($P < 0.05$). How-

Table 4. Mean Differences for Extent of Plaque.*

Group	N	Aug.-73	May-74	Difference	% Reduction	P
I–Betadine	104	1.51	0.99	−0.52	34.4	<0.001
II–Betadine-placebo	114	1.66	1.20	−0.46	27.7	<0.001
III–Isotonic saline	110	1.52	0.90	−0.62	40.7	<0.001
IV–Deionized water	108	1.44	1.07	−0.37	25.6	<0.001
Totals	436					

Analysis of variance for May extent of plaque average scores showed a significant difference at the 1% level.
* Rosa Benitez School, Caguas, Puerto Rico, all subjects, August, 1973–May, 1974.

Table 5. Means Differences for Total Streptococcal Colony Counts ($\times 10^4$)*

Group	N	Aug-73	N	May-74	Differences	% Reduction	P
I Betadine	20	92.1	20	8.4	−83.7	90.9	<0.01
II Betadine-placebo	17	113.5	17	14.7	−98.8	87.0	<0.01
III Isotonic saline	16	84.3	16	9.4	−74.7	88.6	<0.01
IV Deionized water	15	38.0	15	13.5	−24.5	64.4	<0.05
Totals	68		68				

An analysis of variance for August 1973 and May 1974 group means did not detect any significant differences.
Aug. 1973-F with (3,68) d.f. = 2.436; May 1974-F with (3,68) d.f. = 1.212.
* Second grade students, August, 1973–May, 1974.

ever, a higher difference ($P < 0.01$) in gingivitis scores had been recorded for this group at the onset of the study. The reductions before treatment and after treatment gingivitis average scores were significantly different for Groups I, II and III while the Group IV decrease exhibited a marginal difference.

Mean scores among groups for extent of buccal plaque at the end of the school year were found to be significantly different (Table 4). The isotonic saline average was significantly lower ($P < 0.01$) The reductions before treatment and after treatment extent of plaque average scores for all groups revealed the highest level of significance ($P < 0.001$).

In the subset of children, analysis of the data was limited to 68 students who had complete bacteriological records.

An analysis of variance on after treatment group mean scores of total streptococcal colony counts (Table 5) did not detect any significant variation among the groups. T-tests measuring the August 1973, May, 1974, within group reductions in mean scores, were significantly different for the four population samples. The results for the relative proportions of *S. mutans* are summarized in Table 6. The four treatment groups at the end of the school year exhibited minor reductions in per cent occurrence which were not significant either between or within samples. However, it should be pointed out that the values given refer to the per cent of the total plaque streptococci of which *S. mutans* is one constituent and that, as shown in Table 5, there was a reduction in total streptococci ranging from 64 to 90 per cent in the study populations. The same condition applies to the findings for the *S. sanguis*, *S. salivarius* and other streptococci data. For *S. sanguis*, significant differences among the treatment groups were not detected, but a significant per cent increase was observed within the saline treated group. Table 8 which summarizes the data on *S. salivarius* shows no significant changes either between or within treatment groups. Table 9 shows that isotonic saline was the most effective of the four rinses tested in reducing proportions of other than the specific oral streptococci identified. Also, the within saline group mean score was significantly less ($P < 0.01$) whereas the deionized water group mean for other streptococci was significantly increased ($P < 0.02$).

DISCUSSION

The mean net caries increments noted at the end of the school year showed that none of the four oral rinses had a

Table 6. *S. mutans*: Per Cent of Total Plaque Streptococci.*

Group	N	Aug-73	N	May-74	Difference	% Change	P
I Betadine	20	3.9	20	2.9	−1.0	−25.6	N.S.
II Betadine-placebo	17	6.3	17	4.5	−1.8	−28.6	N.S.
III Isotonic saline	16	4.5	16	4.3	−0.2	− 4.4	N.S.
IV Deionized water	15	2.6	15	2.0	−0.6	−23.0	N.S.
Totals	68		68				

An analysis of variance for August 1973 and May 1974 group means did not detect any significant differences.
Aug. 73-F with (3,68) d.f. = 0.187; May 74-F with (3,68) d.f. = 0.460.
* Second grade students, August, 1973–May, 1974.

Table 7. *S. sanguis*: Per Cent of Total Plaque Streptococci*

Group	N	Aug-73	N	May-74	Difference	% Change	P
I Betadine	20	32.7	20	52.4	+19.7	+60.2	N.S.
II Betadine-placebo	17	45.3	17	40.7	− 4.6	−10.0	N.S.
III Isotonic saline	16	32.7	16	58.1	+25.4	+77.7	<0.01
IV Deionized water	15	48.6	15	46.1	− 2.5	− 5.1	N.S.
Totals	68		68				

An analysis of variance for August 1973 and May 1974 group means did not detect any significant differences.
Aug. 1973-F with (3,68) d.f. = 0.972; May 1974-F with (3,68) d.f. = 1.614.
* Second grade students, August, 1973–May, 1974.

significantly different cariostatic effect. The low caries increments observed in all groups may relate to the striking decrease in total numbers of streptococcal colonies found on occlusal surfaces of permanent first molars and to the significant decreases in extent of buccal plaque. These observations suggest that the cariogenic challenge was reduced by a reduction in the numbers of plaque microorganisms as a result of brushing. However, other factors such as water fluoridation and the relative small numbers of permanent teeth at risk may also have influenced these results.

After 9 months of treatment, significant reductions in mean gingivitis scores were observed for the betadine, betadine-placebo and saline groups while children in the deionized water group also exhibited marked improvement in gingival status. The mechanical action of toothbrushing and supervision by dental assistants in part explain these findings. The program stimulated a strong sense of dental awareness among the majority of participants and this may have led to a higher frequency of toothbrushing at home. Within groups, the four test oral rinses had comparable effectiveness in reducing the extent of buccal plaque. Again, a brushing rather than a test solution effect is suggested. However, when the plaque reducing capacity among the test solutions was assessed, isotonic saline was found to be the most effective oral rinse. This finding could relate to the following observations: (1) much of the plaque in the saline treated group seemed to have lost its adhesiveness, (it was easily removed with a cotton-tipped applicator) and (2) clinical observations of stained saline treated plaque revealed punch-out areas of varying dimensions and depth, lacking the glistening homogeneous appearance.

In the subset of children studied bacteriologically, the value of supervised toothbrushing demonstrated a marked reduction in after treatment average total streptococcal colony counts observed in all groups. These results indicated the hygienic status of these most caries-prone surfaces considerably improved. The antimicrobial effectiveness of povidone-iodine in reducing gingival bacteria as reported in another study[2] was not as evident against *Streptococcus mutans* on occlusal surfaces. During 9 months after treatment there were detectable proportions of these organisms in 50 per cent of the children in the betadine group as compared to 47 per cent prevalence of these bacteria in the alcohol-placebo group.

Table 8. *S. salivarius*: Per Cent of Total Plaque Streptococci*

Group	N	Aug-73	N	May-74	Difference	% Change	P
I Betadine	20	3.4	20	6.7	+ 3.3	+ 97.1	N.S.
II Betadine-placebo	17	8.8	17	5.2	− 3.6	− 40.9	N.S.
III Isotonic saline	16	3.4	16	7.1	+ 3.7	+108.8	N.S.
IV Deionized water	15	14.4	15	3.1	−11.3	− 78.4	N.S.
Totals	68		68				

An analysis of variance for August 1973 group means revealed a significant difference. Group IV mean score was significantly higher. May 1974 group averages were not significantly different.
Aug. 1973-F with (3,68) d.f. = 2.866-significant at <0.05 level; May 1974-F with (3,68) d.f. = 0.424.
* Second grade students, August, 1973–May, 1974.

Table 9. Other Streptococci: Per Cent of Total Plaque Streptococci*

Group	N	Aug-73	N	May-74	Difference	% Change	P
I Betadine	20	60.0	20	37.5	−22.5	−37.5	N.S.
II Betadine-placebo	17	39.5	17	49.5	+10.0	+25.3	N.S.
III Isotonic saline	16	58.8	16	30.5	−28.3	−48.1	<0.01
IV Deionized water	15	34.4	15	48.7	+14.3	+41.6	<0.02
Totals	68		68				

An analysis of variance for August 1973 group means did not detect any significant differences. An analysis of variance for May 1974 group averages revealed a significant difference ($P < 0.05$). Group III score was significantly lower.

Aug. 73-F with (3,68) d.f. = 2.416; May 74-F with (3,68) d.f. = 3.530-significant at <0.05 level.

* Second grade students, August, 1973–May, 1974.

The reason for the significantly higher proportions of *S. sanguis* in plaque harvested from occlusal surfaces of the saline treated group is not clear. However, this finding does not seem to be a chance occurrence but rather the result of some unknown action of the saline rinse. Marked reductions in proportions of *S. salivarius* were found for both placebo groups whereas a substantial per cent increase was observed for both the betadine and saline samples. The increases in proportions of *S. sanguis* and *S. salivarius* were accompanied by a decrease in the proportions of other streptococci, suggesting a selective effect of these treatments on different types of plaque streptococci. In contrast, other streptococci significantly increased in the water placebo sample.

The etiologic significance of the fluctuations in proportions of specific plaque streptococci observed in the four treatment groups, is not readily apparent in the data arising from this study. However, future studies testing more efficacious mouthrinses may lead to more clear-cut changes in the oral flora. Such changes may be useful in assessing the role of specific organisms in the etiology of caries and periodontal disease.

CONCLUSIONS

There was no significant difference in the caries increment during a 9 month study among groups treated with povidone-iodine, alcohol placebo, isotonic saline and deionized water mouthrinses.

Significant improvements in the gingival and dental plaque status of all study groups suggest a mechanical effect rather than a consequence of the oral rinses.

Supervised toothbrushing and mouthrinsing were significantly effective in reducing mean streptococcal colony counts on occlusal surfaces.

The specific effect of the mouthrinsing regimes on *S. mutans*, *S. sanguis*, *S. salivarius* and other streptococci in plaque were difficult to interpret because they were apparently overshadowed by the mechanical effects of brushing and rinsing on the plaque mass.

ACKNOWLEDGMENTS

The authors wish to thank Dr. Jose M. Saldana, Assistant Secretary of Health, Dr. Jose M. Gonzalez, Director of Dental Research, and Dr. Emilio Davila, Caguas Dental Regional Chief, Department of Health, Commonwealth of Puerto Rico, for their valuable assistance throughout the length of the study. We wish to thank the National Institute of Dental Research, Biometry Section for the statistical analysis and computer processing of the clinical findings.

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The Pattern of the Carious Attack in Children as a Consideration in the Use of Fissure Sealants

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It has been shown that pit-and-fissure sealants of the bis-GMA and cyanoacrylate types can substantially reduce the incidence of caries in pits and fissures of posterior teeth.[3,5,12] The protective benefits have been shown to last at least two years and may well last longer, though the ultimate protective life of sealants has yet to be established.

Fissure sealants do not appear to be equally retentive and efficacious on all tooth types. Several studies, for example, found that permanent teeth retained the material better than primary teeth and were better protected against caries.[3,10,15] In studies in which only permanent teeth were treated,[5,12] it was found that the sealant was more retentive and efficacious on bicuspids than on molars. These findings could be related both to tooth morphology[14] and to accessibility of the tooth surface concerned,[4,11] although these problems can be expected to diminish as materials and equipment become more efficient.

Another factor which must be considered when assessing the long-term effectiveness of fissure sealing is the pattern of carious attack in different tooth-types. If, for example, it is known that the initial carious attack in a particular tooth-type occurs most commonly on the occlusal surface, and if it is also known that few of these same teeth develop proximal lesions at least until some years later, then fissure sealing is likely to be of benefit to them.

In a population where dental care is readily available, teeth which develop proximal lesions some time after the initial lesions occur on the occlusal surfaces demand operative treatment at least twice, once when the initial occlusal lesion is detected and again when this restoration is extended to become occlusal-proximal. It can be hypothesized that if the occlusal surfaces of these teeth were sealed soon after eruption, then one round of operative treatment would be eliminated for many children, with obvious savings in time and cost. In fluoridated areas, where proximal caries is prevented to a greater extent than is occlusal caries,[1,13] no operative treatment at all would be needed in many of these sealed teeth.

On the other hand, however, if the initial carious attack in a particular tooth type was known to occur most frequently in a proximal surface, then there would be little point in sealing the occlusal surfaces of these teeth as they would need operative intervention anyway in the preparation of an occlusal-proximal restoration. A knowledge of the patterns of carious attack in different tooth types would be helpful when attempting to reach a prognosis for the fissure sealing procedure, and such knowledge would also be useful when priorities are to be determined in public programs.

Longitudinal data on the progression of dental caries in children in the United States are scarce, and conclusions cannot be firmly reached from cross-sectional data. This paper examines the pattern of caries in a group of elementary school children, and uses the data obtained to form hypotheses on the appropriateness of fissure-sealing procedures in several tooth-types.

DESIGN OF THE STUDY

The study population comprised 421 children in the pre-kindergarten through sixth grades in two schools in southeast Michigan. Both schools were situated in low socioeconomic communities, and

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Table 1. Four Hundred Twenty-one Children Examined by Grade, With the Modal Age of Each Grade, Numbers and Proportions Caries-free*, and Mean DMF and DF Scores for Each Grade, Southeastern Michigan, 1974.

Grade	Modal Age	No. of Children	No. Caries-free*	Per Cent Caries-free*	Mean DMF	Mean df
pre-K	4	38	28	73.7	0	1.1
Kindergarten	5	70	35	50.0	0	1.9
1	6	45	10	22.2	0.3	3.1
2	7	80	26	32.5	0.3	2.3
3	8	57	14	24.6	1.1	2.7
4	9	57	9	15.8	1.2	2.7
5	10	39	5	12.8	2.3	2.0
6	11	35	5	14.3	1.9	1.1
		421	132	31.4	0.8	2.2

* "Caries-free" means no caries or restorations detected in any teeth present. It is possible that caries could have been present in teeth previously exfoliated or extracted.

both were in artificially fluoridated areas. However, many children at both schools were known to have come recently from other parts of the country where there was little fluoridated water, so the prevalence of dental caries in the group was unlikely to be typical of that found when children have lived all their lives in fluoridated areas.

All children were examined while seated in portable dental chairs by one of the two standardized examiners. Portable dental lights, plane mirrors and sickle explorers were used. Radiographs were not taken, and teeth were not dried prior to examination. All surfaces of primary and permanent teeth were examined and recorded as sound, decayed or filled. When a primary tooth was not present and had not been replaced by its permanent successor, it was merely recorded as "not present." No attempts were made to determine whether it had been extracted or whether it had exfoliated naturally. Permanent teeth not present where one might have been expected were recorded as unerupted or extracted according to the examiner's judgment. Diagnosis was primarily visual, the explorer was used in areas of uncertainty. Caries was only recorded when there was an obvious lesion visible, if there was visible undermining of enamel, or if a break in the enamel was big enough to admit the explorer and softness was detected at the base of the lesion.

Table 1 shows the distribution of the children by grade, the modal age of each grade, the numbers and proportion who were caries-free (meaning that no tooth present in the mouth had caries or restoration), and the mean DMF tooth[7] and df tooth[16] scores by grade.

For the purposes of this paper, detailed analysis was restricted to three tooth-types, the first and second primary molars and the first permanent molar. These teeth were present in sufficient numbers to allow analysis, and all three are usually considered likely to benefit from application of fissure sealant. Upper and lower teeth of the same tooth-type were combined. There were only 88 second permanent molars erupted, all except three of these were caries-free. A small number of bicuspids were erupted, all except one were caries-free.

RESULTS

Teeth with restorations or untreated lesions were classified into two groups, (1) those where sealing would have been obviously an appropriate procedure, meaning that the lesions or restorations were on the occlusal surface only, or were on the occlusal surface with buccal or lingual extensions, or were buccal or lingual pit-and-fissure lesions only. (2) lesions or restorations with proximal involvement, and which therefore would require, or did require, operative intervention whether the occlusal and smooth surfaces were effectively sealed or not.

The only teeth of the three designated tooth-types not included in this classification were those where only roots were present, or which

were crowned. These teeth were not included as it was not possible to record which surfaces were originally affected by caries.

Table 2 shows the condition of all erupted teeth in the three tooth-types tabulated. Those teeth classified as carious or restored in this table are then shown in Table 3, divided by age-groups into the two categories previously described, that is those teeth in which sealing would have been appropriate and those in which it would have been inappropriate because of the presence of proximal lesions.

The figures in Table 3 show that 20.2 per cent of all lesions and restorations on the first primary molar involved only the occlusal surface, or the occlusal surface with a buccal or lingual extension. In addition, because 75 per cent of these teeth present were sound (Table 2), only 4.5 per cent of the total number of first primary molars could have potentially benefitted from sealant.

Higher proportions of the lesions in the second primary molars, 56.9 per cent, and in the first permanent molars, 91.5 per cent, were occlusal lesions only. Even though 65.3 per cent of the second primary molars were sound (Table 2), 18.6 per cent of them would have potentially benefitted from sealant. And although 76.1 per cent of the first permanent molars were sound, so few of the remaining teeth were proximally affected that 21.1 per cent of them would have received potential benefit from sealant.

When the results are looked at by age (Table 3), it can still be seen that even in the younger groups the patterns are similar. For the first primary molar, even in the 4–5 age-group there were still only 27.1 per cent of affected teeth where the lesions did not involve the proximal surface. By contrast, over 90 per cent of affected first permanent molars in all age-groups had lesions in the occlusal surfaces only, or in the occlusal with buccal or lingual extensions. The second primary molar, however, appeared to show a change with age. Most teeth affected at ages 4–7 had occlusal lesions, whereas there were more teeth with proximal lesions in older children.

DISCUSSION

Firm conclusions cannot be based on retrospective studies of this nature. They should therefore be used only to develop hypotheses. The principal reason is that there is an inherent problem in using retrospective, cross-sectional data to reach conclusions about processes which have developed over time, such as the sequential involvement of different tooth surfaces in the carious process.

Another question in the study design concerns the comparability of clinical and epidemiological diagnoses; combining the carious and restored teeth is justified only if the criteria used by clinicians to restore teeth are the same as those used by the epidemiologist to diagnose carious teeth. Usually such an assumption cannot be made, and there is some evidence[8,9] to show that the diagnostic criteria applied may be quite different. In this study, however, the population is undertreated, as 47.8 per cent of the total df count for the group was decayed teeth, and 34 per cent of the total DMF comprised untreated decayed teeth. Where treatment needs of this magnitude still exist, it is likely that such treatment as the group has received has been for obvious disease over which there would be little diagnostic quibbling. This suggestion is strengthened by the data in Table 3, which show that in this group carious

Table 2. The Condition of All Erupted First and Second Primary Molars, and First Permanent Molars in 421 Children in Southeastern Michigan, 1974.

Tooth Type	Total Erupted	Teeth Not Present*	Sound, Untreated Teeth	Crowns or Roots	Carious Teeth	Restored Teeth
1st primary molar	1,684	403	961	38	139	143
2nd primary molar	1,684	243	941	29	221	250
1st permanent molar	1,239	10	943	3	95	188

* Exfoliated or extracted for primary teeth, extracted for permanent teeth.

Table 3. Caries and Restored Teeth, in Which Only Occlusal Surfaces Were Attacked and Those Where Proximal Surfaces Were Involved. For Three Tooth-types, by Age, 421 Children, Southeastern Michigan, 1974.

Age	n	Occlusal Surfaces Only*			Proximal Surfaces Involved			Percentage of Teeth With Only Occlusal Lesions		
		Carious	Restored	Total	Carious	Restored	Total	Carious	Restored	Total
					First Primary Molar					
4–5	108	10	3	13	20	15	35	33.3	16.7	27.1
6–7	125	9	14	23	54	35	89	14.3	28.6	20.5
8–9	114	5	10	15	29	52	81	14.7	16.1	15.6
10–11	74	0	6	6	12	8	20	0	42.9	23.1
All	421	24	33	57	115	110	225	17.3	23.1	20.2
					Second Primary Molar					
4–5	108	40	18	58	13	8	21	75.5	69.2	73.4
6–7	125	44	49	93	36	23	59	55.0	68.1	61.2
8–9	114	25	52	77	33	52	85	43.1	50.0	47.5
10–11	74	6	34	40	24	14	38	20.0	70.8	51.3
All	421	115	153	268	106	97	203	52.0	61.2	56.9
					First Permanent Molar					
6–7	125	17	13	30	1	1	2	94.4	92.9	93.8
8–9	114	46	66	112	5	6	11	90.2	91.7	91.1
10–11	74	25	92	117	1	10	11	96.2	90.2	91.4
All	313	88	171	259	7	17	24	92.6	91.0	91.5

* Includes occlusal surfaces with buccal or lingual extensions, also buccal or lingual pit-and-fissure lesions. Buccal and lingual smooth-surface lesions were excluded.

attack seems to follow a similar pattern whether carious teeth only are counted, restored teeth only, or both are combined. It is likely that the question of diagnostic differences becomes more marked in groups in which a higher level of treatment is received. As an illustration, it has been shown that higher socioeconomic groups tend to have higher DMF scores,[6] a finding attributable to their greater use of dental service.

The weakness of retrospective analysis is that where a tooth is seen to have both proximal and occlusal involvement, one cannot be sure which came first and what the time difference between them was, if any. Where a proximal restoration is in place, there is no certainty that an occlusal lesion was ever present, as the occlusal surface must be cut in order to hold the restoration. Missing teeth cannot be discounted, for 23.9 per cent of first primary molars and 14.4 per cent of second primary molars were not present (Table 2), meaning that they had exfoliated or been extracted. The tacit assumption in this study is that the distribution of caries in extracted teeth, by surface, was similar to that found in teeth that are present in the mouth, an assumption that may or may not be justified. Only 0.8 per cent of the first permanent molars had been extracted, a small enough proportion to be ignored in considering this tooth-type.

The most confident hypothesis can be drawn regarding the first permanent molar. In all age groups, over 90 per cent of lesions in that tooth were occlusal or occlusal with extensions, they were "sealable" lesions. Even in children aged 10–11, only 11 of 128 lesions had proximal involvement. It is possible that these children may develop more interproximal lesions in their early teenage years as English children have been shown to do,[2] but the data presented indicate that effective sealing soon after eruption of the first permanent molars would probably have prevented nearly all the caries seen in those teeth in this group of children. Although only 23.9 per cent of all first permanent molars in the whole group had been attacked

by caries (Table 2), 46.3 per cent of those teeth in the 10–11 age group had been attacked. The data therefore lead to the hypothesis that routine fissure-sealing of first permanent molars, soon after eruption, is likely to be an appropriate procedure.

The first primary molar, by contrast, appears to be a tooth where routine fissure-sealing is not indicated, for even at age 4–5 only 27.1 per cent of carious first primary molars had lesions that were "sealable." It appears that the initial lesion in these teeth is frequently proximal and therefore it can be hypothesized that routine sealing of first primary molars is not appropriate. It is more difficult to reach a suitable hypothesis for the second primary molar as the data are more equivocal. In practice, however, as the second primary molar is considered an important tooth in arch development, the data are not conclusive enought to suggest that sealing is inappropriate.

These hypotheses could be tested in subsequent clinical trials of fissure sealants. Certainly a more thorough knowledge of the natural history of caries development could lead to more precise and less expensive preventive therapy.

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Journal of PREVENTIVE DENTISTRY

Carter, HG, Barnes, GP: Effects of Three Mouthwashes on Existing Dental Plaque Accumulations. J Prev Dent 2 (May-June) 1975.

Abstract: The results of this investigation indicate that, when used under the conditions of this experiment, a commercially available mouthwash containing cetylpyridinium chloride will significantly reduce the quantity of bacterial plaque accumulation on the human dentition. When used under the same experimental conditions, a commercial mouthwash containing essential oils, benzoic acid, boric acid, and methyl salicylate; a commercial mouthwash containing benzethonium chloride; and a placebo mouthwash of colored flavored water did not reduce existing plaque accumulations. The data suggests that use of the cetylpyridinium chloride mouthwash might be an effective adjunctive preventive dentistry measure when used with other home oral hygiene procedures such as toothbrushing and dental flossing.

Robinson, PJ: Possible Roles of Diseased Cementum in Periodontitis. J Prev Dent 2 (May-June) 1975.

Abstract: The role of cementum in periodontal disease remains in question despite extensive clinical and experimental study. In particular, the principal question remain whether cementum has any significance in periodontitis other than merely as a vehicle for calculus attachment. Recent evidence indicates that cementum associated with periodontal disease had morphological and biochemical changes that may contribute to the perpetuation of periodontitis. It is, therefore, important that this evidence and its implications be discussed.

Abstracts of Articles in This Issue of the Journal of Preventive Dentistry
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Randolph, P: The Continuing Vitamin C Controversy. J Prev Dent 2 (May-June) 1975.

Abstract: Dr. Linus Pauling has suggested supplemental vitamin C taken daily in gram amounts will reduce susceptibility to the common cold. Medical and dental practitioners have been questioned regarding the value of the vitamin and the scientific community became divided regarding the supplemental use of the vitamin. Dental literature is replete with articles both in support and condemnation of the use of vitamin C in oral health and disease. Medical and nutritional literature has recently suggested the possibility of toxicity and/or tissue dependency with high level supplementation of the vitamin. Due to the controversy, a simple test to evaluate vitamin C status of an individual would be valuable. The lingual vitamin C

Duany, LF, Fitzgerald, RJ, Llorente, M, Zinner, DD: Effects of Povidone-iodine and Isotonic Saline on the Oral Health of Children. (May-June) 1975.

Abstract: The purpose of this supervised longitudinal clinical trial was to determine the effect of four mouthrinses and toothbrushing on caries incidence, gingivitis, extent of plaque and oral streptococci on occlusal surfaces of permanent first molars on a subset of children. The analysis of the clinical (N = 436) and bacteriological (N = 68) data was limited to children who had a complete examination record. Analysis of the mean net DMFS increments did not detect any differences among the groups. Significant improvements in the gingival and dental plaque status of all study groups suggest a mechanical effect rather than a consequence of the oral rinses. The effectiveness of supervised tooth brushing and mouthrinsing was

Marcus, M: Effects of Cetylpyridinium Chloride Containing Lozenges on Dental Plaque and Gingival Bleeding. J Prev Dent 2 (May-June) 1975.

Abstract: The purpose of this examiner-blind clinical investigation was to evaluate the effects of commercially available throat lozenges containing cetylpyridinium chloride on bacterial plaque and gingival hemorrhage. Under the conditions of this experiment, the following findings were noted: Use of the cetylpyridinium chloride lozenges did not significantly inhibit new plaque formation; the lozenge use did not significantly reduce existing bacterial plaque accumulations; use of cetylpyridinium chloride lozenges had no significant effect on gingival sulcular bleeding; the results of this study, involving cetylpyridinium chloride lozenge usage, are in contrast with the results obtained with mouthwashes containing the same agent.

Burt, B A, Graves, R C: The Pattern of the Carious Attack in Children as a Consideration in the Use of Fissure Sealants. J Prev Dent 2 (May-June) 1975.

Abstract: This study considered the pattern of caries development in three tooth-types among a group of 421 schoolchildren, in grades kindergarten through six, in southeastern Michigan, with the object of hypothesizing whether these teeth would have benefitted from a hypothetical program of fissure-sealing. The three tooth-types were the first and second primary molars and the first permanent molars. Results showed that over 90 per cent of carious lesions in the first permanent molars did not involve the proximal surfaces, and were thus considered "sealable" lesions. There were 56.9 per cent of lesions in the second primary molar which were "sealable," but only 20.2 per cent of lesions in the first primary molar did not have

demonstrated by the significant reduction in average streptococcal colony counts. The effect of the mouthrinsing regimes on specific streptococci in plaque were difficult to interpret because they were apparently masked by the mechanical effects of brushing and rinsing on the plaque mass.

test has been suggested. The test itself is controversial. Some articles in dental literature indicate the test to be satisfactory for the measurement of vitamin C nutriture while other reports indicate the test to be unreliable. The possibility of vitamin C deficiency in the American population has been studied. Two surveys indicate little incidence of deficiency in this country. Even if sub-optimal vitamin C intake could be detected in a dental office, a question arises regarding the amount of vitamin supplement safe to recommend.

some proximal involvement. It is hypothesized from these results, that routine sealing of first permanent molar, soon after eruption, is a rational procedure in view of the pattern of caries in that tooth. Less firm hypotheses can be made concerning the second primary molar, and routine fissure sealing is suggested as an inappropriate procedure for the first primary molar.

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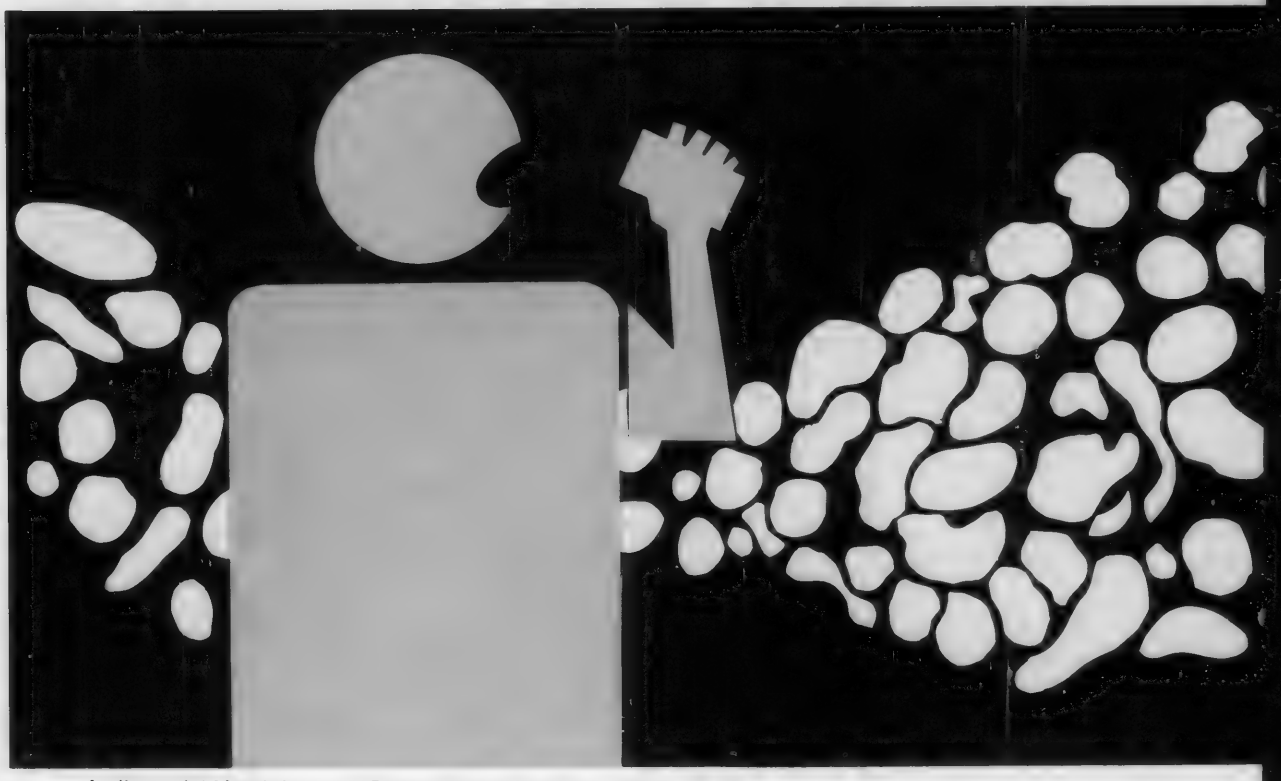

Antibacterial Mouthrinse and Dental Plaque Reduction. See page 10

☐ Evaluating Long-term Periodontal Therapy: What Constitutes Success or Failure? ☐ Dental Plaque Reduction with an Anti-bacterial Mouthrinse: Ultrastructural, Microbiological and Biochemical Changes ☐ Periodontal Disease Information in College Health Education

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Evaluating Long-term Periodontal Therapy

What Constitutes Success or Failure?

Harold C. Sternlicht, D.D.S., Ph.D.*

The case history that follows is of someone who was once a patient of mine. Most of the details are therefore known firsthand, a very few had to be reconstructed. I report it here for several reasons. First, because there appears to be some misunderstanding about the significance of pocket formation in periodontal disease. This needs to be aired. Second, it illustrates the problems that may arise when there is no communication between patient and practitioner and between practitioners treating the same patient. Though dentistry may be one of the last remaining strongholds of cottage industries, seclusion can be a serious disadvantage and it is necessary to remind those who practice in this way that the habit of consultation should be acquired. Patients are better served when information is freely disseminated and other practitioners are accepted as colleagues rather than adversaries.

CASE REPORT

Advanced periodontal disease in a 43-year-old woman was treated with excellent results as demonstrated by the absence of inflammation, minimal pocket depth and firm teeth. This case was maintained for a period of 16 years with the help of some very fine restorations and fixed replacements which were made by the referring dentist. Despite a poor prognosis, several questionable teeth were retained. The worst of these was extracted 11 years after treatment. Home-care was erratic. Sometimes oral hygiene was faithfully performed; at other times the patient obviously paid it little attention. On the latter occasions, more intensive curettage would be performed in an attempt to reverse the effects of neglect.

About one month after her last check-up, the patient called complaining of pain. Examination revealed some recurrent inflammation near the furca of a questionable maxillary molar but the quality of the pain was more characteristic of a developing pulpitis. This was not an unlikely possibility since cast gold crowns had been placed some time earlier.

Roentgenograms (Figs. 1 to 4) made triannually clearly showed that, except for the maxillary premolar that had to be extracted 11 years later and an extremely conical maxillary molar which seemed to have lost some additional alveolar housing, no further generalized bone loss had occurred after treatment. If anything, bone levels remained stable during this period and bone density was obviously improved.

Because signs and symptoms (roentgenograms-vitality test) were inconclusive, the patient was advised to wait until they should become more definite. It was hoped in this way to avoid unnecessary or improper treatment.

The patient never returned and the incident was forgotten until she was notified by phone several months later about her next appointment for routine periodontal care. She then told the secretary she was never returning because of the poor treatment she had received; that on the advice of her son who had recently become a dentist, she had visited another periodontist who reputedly demonstrated the presence of pockets to her and advised her that she needed to have surgical treatment redone. To this she agreed, though neither she nor the periodontist made any attempt to consult with me or obtain any early records of roentgenograms which were available. It was also learned that the questionable molar was removed at the time of surgery.

DISCUSSION

Because the pain of pulpitis or a combined periodontal-pulpal defect is very severe as compared to the pain of a

* 1409 Medical Towers, Houston, Texas.

periodontal abscess, a patient could be easily persuaded to undertake almost any remedy to gain relief although the simple solution would be extraction of the offending tooth or endodontics. To convince the patient that periodontal surgery needs redoing simply because of the presence of some pockets may possibly be excused as misguided zeal for the surgical treatment of periodontitis. This would be a generous interpretation for the underlying motivation, but surgery that is not only unnecessary, but could result in further bone loss can hardly be condoned.

Just as most chronic diseases are never completely cured, the treatment of periodontal disease does not generally restore the patient to an ideal state in which all pockets are healed, tooth mobility disappears and the occlusion is totally rehabilitated. Usually some deficiencies persist since all defects cannot be eliminated or some reappear because many corrections achieved immediately following treatment tend, with time, to reverse themselves. However, the persistence of a few stigmata of the disease does not represent failure. In the final analysis, the true measure of a successfully treated care of periodontal disease is the durability of the natural dentition. For the most lasting results, it is best that the supporting tissues be relatively freed of clinical inflammation, with pocket depth and tooth mobility stabilized at acceptable levels and alveolar bone resorption arrested, as evidenced by correctly made roentgenograms. Some allowances must also be made for changes associated with senescence.

Fig. 1. Maxillary incisor and cuspid areas (1957–1971). Though angulations are not identical nor optimal, there is no apparent change in alveolar bone levels.

For advanced and even moderate cases of periodontal disease it is no easy matter to predict the long term results of treatment because of the many variables that exist between subjects and even within tissues of the same individual. Because the prognosis can be uncertain, many operators, preferring to minimize risk, suggest the removal of teeth with advanced disease. This is not always a satisfactory solution since the replacements necessitated by multiple extractions often contribute to future problems for the retained abutment teeth. These may arise from overloading, the initiation of pulpal disease, or interference with hygiene. On the other hand, the maintenance of teeth with a cloudy prognosis also involves substantial difficulties since diminished supporting tissues succumb more readily to pernicious irritants following even the most competent therapy. It may be noted parenthetically, that oral hygiene programs, now widely promoted and hopefully practiced, began for the most part as routine home-care operations in an effort to sustain and prolong the gains achieved from treatment. Only later was this aspect overridden by the concept of prevention. This is a pauseful reminder of the evanescence of many surgically achieved benefits.

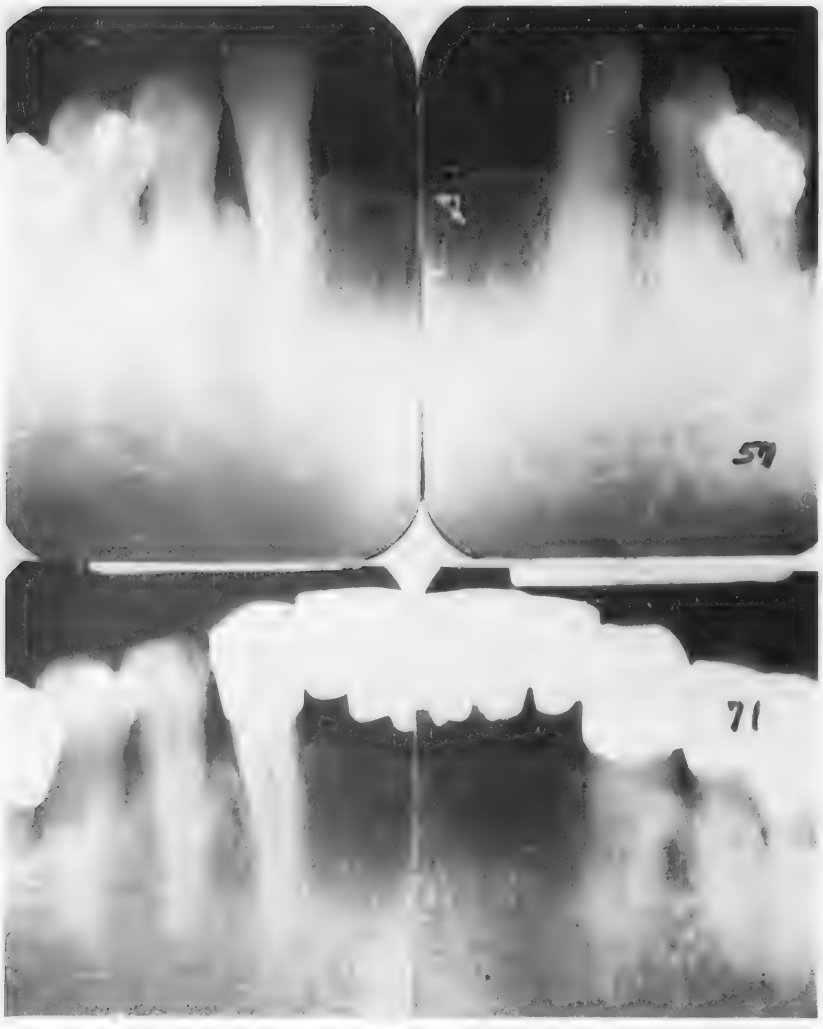

Fig. 2. Mandibular cuspid and premolar areas (1957–1971). Alveolar bone levels appear stable.

In the following discussion patients with periodontal disease will be divided into two classifications: **primary,** consisting of those who have never received formal treatment; **secondary,** which includes those cases which have received treatment but have, nonetheless, some persistent or recurrent signs of active disease.

Primary cases: To determine the needs of the patient who has never experienced periodontal care, the minimal acceptable examination requires a set of undistorted intraoral roentgenograms, made with optimal penetration and density. Most panoramic techniques so far lack sufficient definition for making a precise diagnosis. Measurements of tooth mobility and recording of the location, depth and quality of pocket formation complete the major categories of the clinical examination. Quality refers to the presence or absence of clinical inflammation or suppuration in the adjacent gingiva and to the adherence of the gingiva to the teeth, whether loose or firm. Such observations are necessary in order to make proper distinctions between aggressive, pathologic pockets and deep but relatively innocuous crevices. The best diagnostic information is obtained from a systematic examining procedure, any number of which may be found in standards texts on periodontology.[1,2] Though a detailed anamnesis may provide some clues, patients develop their own chronology following treatment. Time alone proves whether it will be good or bad. Therefore, the handling of inchoate cases should be exacting and complete, carried out by a competent therapist with all the necessary and approved techniques in his repertoire. Treatment should not be delayed, though decisions concerning the removal of questionable but strategic teeth may sometimes be deferred until after treatment is completed and a determination based on more complete evidence can be made. The objectives of this initial episode are to attack the major weaknesses encountered: calculus, pocket formation, tooth mobility, inconsistent alveolar bone levels and so forth. This is followed by a strict program of maintenance involving homecare and periodic office attention.

There are many advantages in having maintenance conducted or supervised by the primary therapist. Special prob-

lems encountered during the treatment phase are known, as is the patient's willingness and ability to carry out the required program of oral hygiene. Detailed records of the regularity and type of office procedures used in post-treatment care as well as pretreatment and periodic post-treatment roentgenograms are available. This cumulative data make possible a reasonably well informed estimate of the quality of control for any case during a particular time interval. Deviations from an optimal level of stabilization may be recognized early and an experienced therapist quickly recognizes whether new problems that arise can be controlled, reversed, or perhaps merely decelerated. If someone new must take charge, their judgment of the progress of the case is hampered by a lack of familiarity. Unfortunately, not all patients can maintain continuity between treatment and maintenance. Because of increased emphasis on periodontal therapy and its greater availability in recent years, the number of treated cases has grown large. Many patients, for personal reasons or because of relocation, change therapists and come under the care of someone unacquainted with their original condition. Should they be evaluated as though they had never had treatment? Not at all.

An examination by the new therapist is essential and like the original examination should include current roentgenograms and recordings of mobility and pocket depth. The use of a probe to detect and measure

Fig. 3. Left maxillary and mandibular molar areas (1957–1971). Pain had been experienced in the maxillary area. No marked change appears in the bone but any of the crowns that were placed could have contributed to the development of a pulpitis.

periodontal pockets, long urged as one of the most critical facets of the examination, has reinforced the concept that periodontal pockets are constantly associated with active periodontal disease, but this is not always true. Pocketing is neither the constant indicator nor the only marker of progressive disease, and the temptation to redo work previously done by another because of the discovery of some residual pockets must be sorely resisted. An accurate profile of a patient's oral condition is better appraised by obtaining a well-documented history rather than by a mere accounting of pocket formation, particularly since clinical measurements of pocket depth and mobility made by different examiners are least reliable for comparisons of past and present periodontal conditions. On the other hand, records of the original diagnostic information including pretreatment roentgenograms and the type of treatment that was performed are most valuable, and communication between former and current operators, wherever possible, can overcome many misunderstandings.

Secondary cases: Secondary cases may be evaluated by the same set of standards used for primary cases, but the data should be weighted in favor of roentgenographic findings over measurements of pocket depth and mobility. For example:

(1) If recorded pocket depth is greater than deemed desirable, but roentgenograms show no progression of alveolar resorption and there is no change in tooth mobility, then to again attempt the surgical elimination of residual pockets ought not

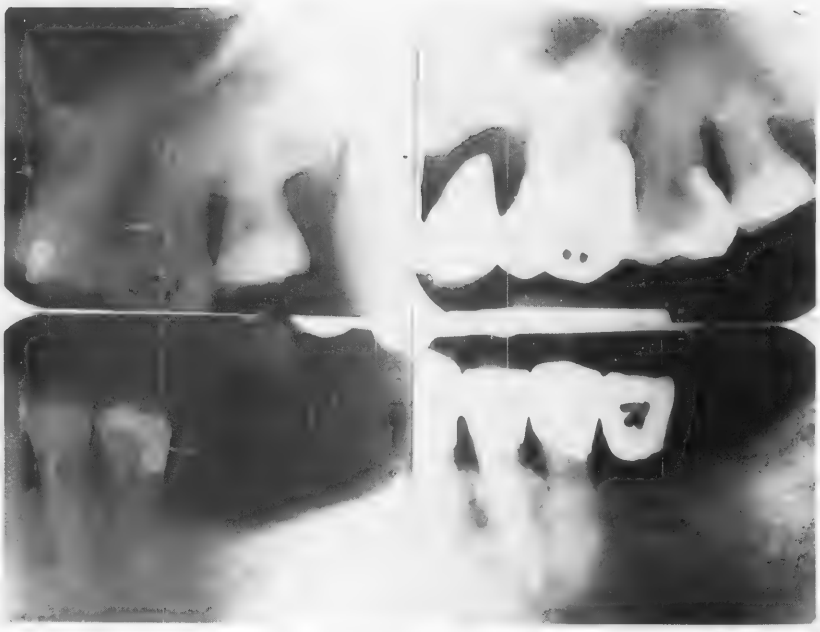

Fig. 4. Right maxillary and mandibular molar area. (1957–1971) The appearance of increased alveolar bone loss around the third molar may not be real but could result from differences between the horizontal angulations of beam direction in the early and late radiographs. No symptoms were noted on this side.

to be considered. Some pockets tend to recur despite all measures taken to eliminate them. Others cannot be eliminated because of architectural or anatomical peculiarities. In this instance the best course of action is to thoroughly curette pocket epithelium and carefully scale the roots. The adequacy of the patient's oral hygiene program must obviously be explored and additions or corrections made if so indicated. The occlusion is also examined for possible sources of trauma, and adjustments made where required.

(2) If roentgenograms show stable alveolar bone levels and minimal pocket depth, but there is increased tooth mobility, then the occlusion needs to be meticulously examined for imbalances, or for any overlooked or recently developed habit patterns. Not only may occlusal corrections and habit control devices be indicated but one must also be alert to possible systemic aberrations which may compound or add to local problems.

(3) Retreatment becomes almost unavoidable when roentgenograms indicate progressive bone resorption, and both pocket depth and tooth mobility are increased. It generally cannot consist of surgery alone. All deficiencies uncovered by the examination, whether they be related to pocket formation or deepening, occlusion, or the performance of hygienic techniques should be considered in any plans of correction. A careful reexamination is required for the patient who continues to break down despite conscientious efforts at oral hygiene and regular professional care. Such a patient displays obvious warning signs which the current operator had best heed. Repeated attempts to achieve a stabilized condition may prove unsatisfactory and fairness directs that the patient be advised of this beforehand. It is tempting to suggest that failing patients undertake intensive medical testing but this rarely uncovers conditions that specifically relate to the present oral disease. They should, however, be encouraged to have thorough medical examinations at regular intervals. Sometimes palliative treatment, and/or the extraction of near hopeless teeth, may be all that can be achieved.

When records show, or a patient admits that post-treatment care has been neglected, whether that care be of a personal or professional nature, evidence of recurrent disease is less surprising and the prognosis for retreatment becomes more favorable. Long-term benefits depend nonetheless on continuing patient cooperation, and evidence of prolonged neglect and lack of concern does not make for a promising future. Under these circumstances, to attempt extensive procedures could be almost futile. Obviously, when retreatment involving periodontal surgery, either localized or of a fairly generalized nature, has to be considered, judgments must be based on ample data and experience. Current clinical signs require careful evaluation. In secondary cases, swelling and pain still require a determination of cause, and summary

assumptions that they arise from recurrent periodontal disease may be unwarranted, as pulpal disease or other conditions may also be responsible for these symptoms. A high incidence of combined pulpal and periodontal disease which has been well documented, makes for even more intricate diagnostic puzzles.

The kind of procedures employed by the primary therapist is of importance. Pockets are more likely to be residual if only "nonsurgical" techniques were used. If these pockets are quiescent, this form of treatment is quite acceptable. Even when treatment is surgical, pockets may recur and even this does not necessarily signify failing results. It is not possible to entirely eliminate every pocket and there is evidence that the surgical elimination of pockets may be less permanent than once believed.[3] Provided that pockets are not of a destructive nature, teeth may survive for even long periods despite their presence.

SUMMARY

I am suggesting, and the major thrust of this article is to point out that the success of periodontal treatment is measured by the durability extended to the natural dentition rather than the mere correction of certain specific signs of the disease such as isolated pocket formation, whose persistence or recurrence is not necessarily an indication that treatment has failed. When a patient is treated for the first time, however, the treatment should be complete with removal of all defects wherever possible. Continuing care, preferably by the primary therapist, is necessary to maintain oral health. Evidence of recurrence and of any new sites of breakdown must be carefully evaluated by the primary therapist or whoever has taken over the responsibility for the care of the patient. To make proper distinctions between periodontitis and any other peripheral conditions such as pulpitis is a special caveat. If there are signs of widespread recurrences, retreatment may be contemplated, provided there are reasonable expectations that long term benefits will result. Otherwise, palliative or symptomatic treatment may be the preferred alternative. In many instances the presence of pockets is insufficient cause for retreatment by extensive surgical means unless it is clear that the pockets are contributing to the destruction of the dentition. Since any surgical experience may have adverse effects, because of the exposure of alveolar bone, considerable thought should be give before this step is undertaken more than once.

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What is new in Preventive Dentistry? The following paragraph is a direct quote from "Dental Hygeia" published in 1838 by Solyman Brown, A.M.

Waxed Silk

The brush will not always effectually remove unhealthy deposites from between those teeth which are in actual contact; and the best substitute known is floss silk, well known to the ladies as the beautiful product of the silkworm when reeled from the coccoon but not twisted into thread or yarn. This substance as sold in the shops in small skeins, should be kept wound upon a ball for occasional use by all persons who pride themselves on personal neatness. About six inches of the floss should be well waxed and drawn between the teeth until all dark deposites shall be wholly removed.

Dental Plaque Reduction with an Anti-bacterial Mouthrinse

Ultrastructural, Microbiological and Biochemical Changes

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H. G. Carter, D.M.D., M.P.H.†, and G. P. Barnes, D.D.S., M.S.D.‡

Previous investigations have shown that many chemical and physical agents can reduce the amount of microbial plaque on tooth surfaces. Net reduction can be achieved by means of one or both of two processes: destruction and removal of previously formed plaque, or inhibition of growth of new plaque. Pulsed water lavage has been extensively studied in this laboratory as a physical means of modifying plaque contents *via* destruction and removal. Electron microscopy observations revealed rapid lysis of microbial cells of the dental plaque after pressured water lavage[2,3]. Chemical agents, such as QR-711 (alexidine), are also under study at this Institute for their effect on plaque accumulation and are the subjects of two reports.[1,4]

This paper is the third part of a series of studies on changes of plaque scores, wet and dry mass, microbial content, protein content and plaque ultrastructure after 5 successive days of treatments with QR-711 in an oral rinse. Summarized here are the results of electron microscopy, microbiological content, and biochemical studies of the dental plaque after such treatment.

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MATERIALS AND METHODS

This investigation was conducted on 17 male volunteers, 17 to 21 years of age, each of whom had an equal number of teeth on each side of the mouth. They did not exhibit advanced carious lesions, severe periodontal diseases, systemic diseases, or allergies.

On the first day, dental plaque on all teeth was stained with 0.5 per cent solution of Fast Green in order to determine plaque score and location. At this time plaque samples were removed from mandibular and maxillary teeth of the right side. The same teeth were then given a prophylaxis. The participants were instructed to continue their usual oral hygiene procedure and to rinse for one minute daily before bedtime with 15 ml of QR-711 (0.035 per cent of alexi-

dine in 18 per cent alcohol solution). No other mouthwash was used. On the sixth day, after 5 days of this rinse regimen, the dental plaque was again stained. The plaque samples from the left and right sides were collected for microbiological, ultrastructural and biochemical determinations. Plaque specimens collected at the beginning and end of the treatment were obtained and examined as follows:

A. *Electron Microscopy*

Samples of plaque from 7 subjects were removed from the gingival third of the buccal surfaces of the maxillary premolars and first molar. Samples were taken from the right maxillary teeth before treatment, after which the right maxillary posterior teeth received a prophylaxis. Following 5 days of rinse regimen with QR-711, plaque was again stained and samples removed from the right and left posteriors for microscopic analysis. Plaque material was placed in buffered glutaraldehyde (2 per cent glutaraldehyde in 0.05 M cacodylate buffer, pH 7.4) at 4 C. Specimens were stained with 1 per cent osmium tetroxide, dehydrated in alcohol and embedded in epoxy resin. Sections were cut using the LKB 8800 ultramicrotome, placed on formvar coated grids, stained with lead citrate and uranyl acetate and examined with the Hitachi HU 11-B electron microscope.

B. *Biochemical Analysis*

Total plaque from 10 subjects was removed from all the teeth

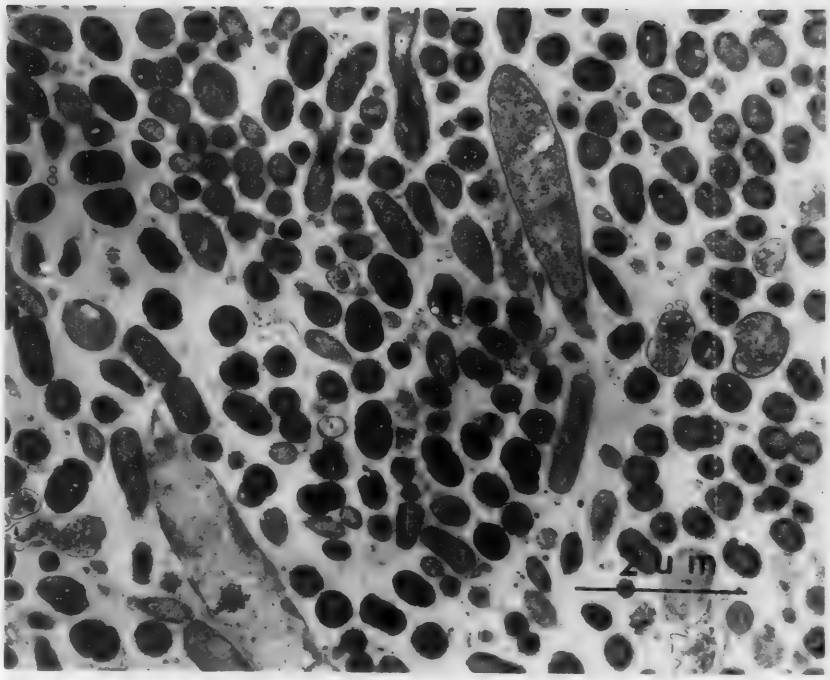

FIG. 1. Electron micrograph of pre-treatment plaque (×24,000).

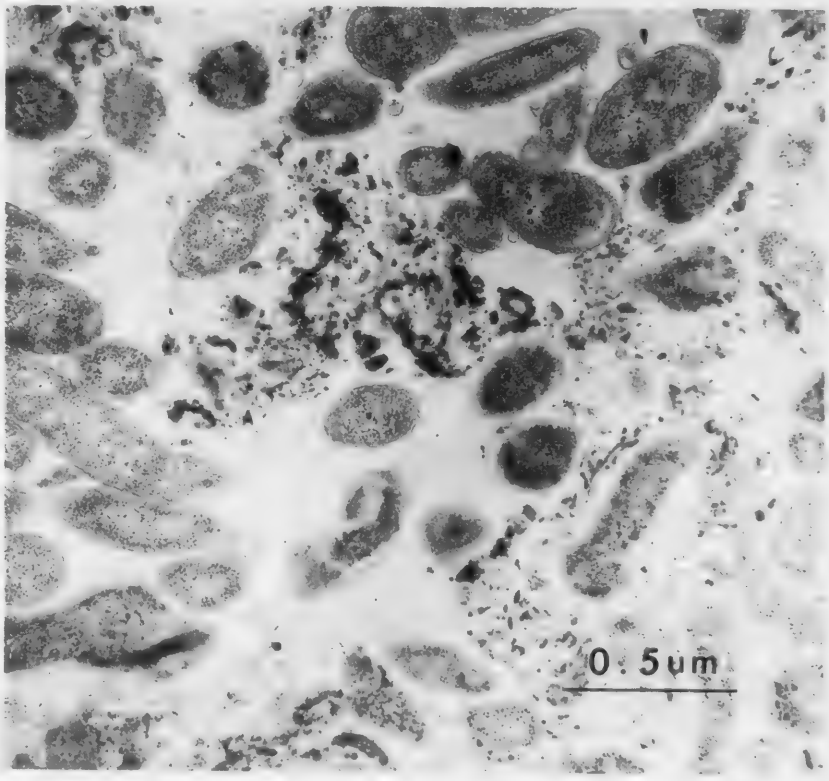

FIG. 2. Electron micrograph of pre-treatment plaque with areas of densely stained intercellular matrix (×24,00).

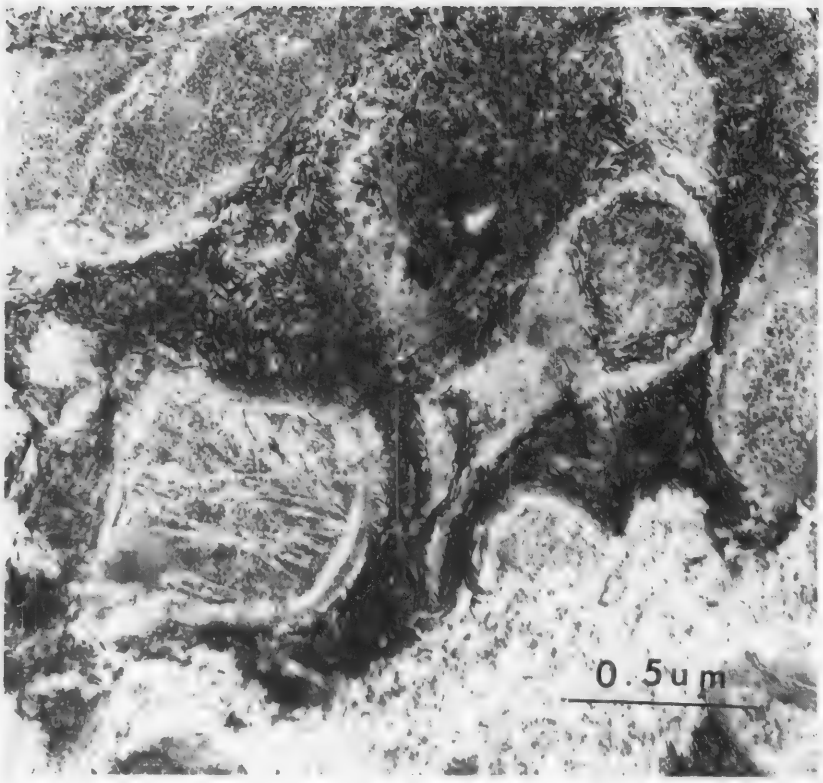

FIG. 3. Electron micrograph of calcified pre-treatment plaque (×25,500).

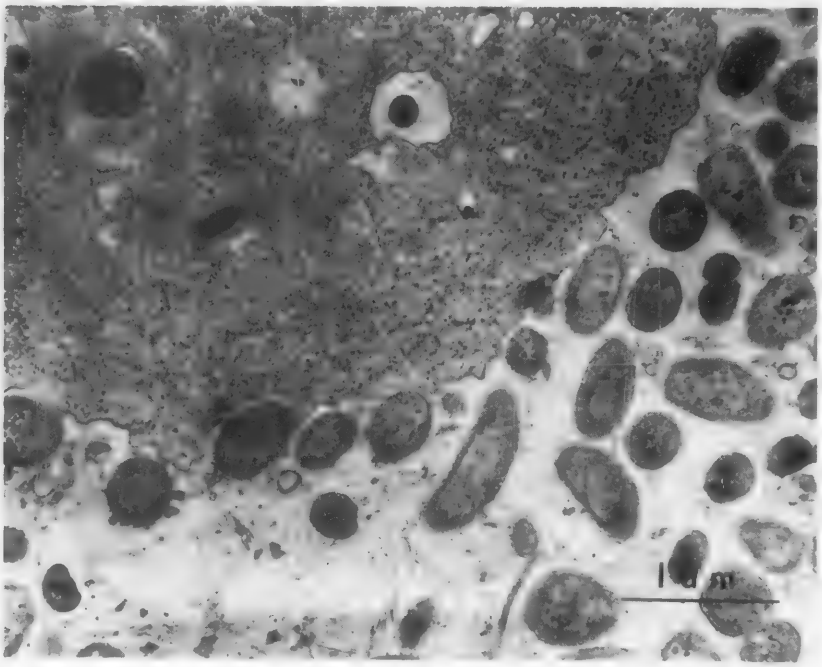

FIG. 4. Electron micrograph of pre-treatment plaque. Leucocyte is shown with several entrapped microorganisms (×21,000).

except the third molars. Plaque from the right side before treatment was compared with plaque from the left side after treatment. The harvested plaque was transferred to pre-weighed plastic screw top vials and the wet weight of the plaque was determined. Two milliliters of 0.4 per cent saline was added to each vial and the contents were frozen. Prior to analysis, the thawed samples were sonicated for 30 seconds to insure complete dispersion. An aliquot was then analyzed for the total protein content according to the procedure of Lowry, et al.[5] The soluble protein component of the plaque was determined using a procedure of Fox and Dawes[3], which entailed extracting an aliquot of the plaque suspension with 0.05 N NaOH for 1 hour at 4 C. An aliquot of the plaque suspension was placed in preweighed vials and lyophilized to obtain the dry weight of the plaque.

C. *Microbiological Analysis*

The method of collecting plaque was similar to that used for the biochemical analysis. Plaque samples from 6 subjects were transferred to preweighed, circular 13 mm Millipore filters (type HA. 0.45 μm) which were placed on Whatman #1 filter paper to remove excess moisture. After 30 seconds the wet weight of samples on Millipore filters was determined. The plaque was then placed into homogenizing flasks containing 2 ml of saline and glass beads, and dispersed with a homogenizer. Serial dilutions in saline were made and 0.1 ml aliquots of appropriate dilutions spread

on blood agar and mitis salivarius agar. Triplicate plates of each media for each selected dilution were incubated aerobically and an equal number of plates incubated anaerobically in an atmosphere of 95 per cent nitrogen and 5 per cent carbon dioxide. Counts were made from plates showing 30–300 colony forming units and represent a mean of three counts.

RESULTS

A. *Ultrastructural Analysis*

Plaque samples from 7 individuals were analyzed for ultrastructural changes after treatment for five days with alexidine. Dental plaque from the right posterior teeth taken before treatment was compared with both new plaque on the same side and intact old plaque from left maxillary teeth obtained at the end of the experiment. Of the 7 individuals examined, a total of 21 samples were studied with electron microscopy.

Untreated dental plaque contained a myriad of microbial forms, including rods, large and small cocci, and interbacterial matrix, some with areas of small crystallites and others with areas of almost fully calcified material (Figs. 1–3). Occasional leucocytic cells were seen to entrap several cocci (Fig. 4). Some areas of the plaque contained small groups of disintegrating bacterial cells, but only rarely were large masses of dead bacteria observed (Fig. 5).

After 5 days of treatment with QR-711, the volume of recoverable plaque for electron microscopy was greatly reduced, both in the preformed plaque present during treatment and the new plaque formed during treatment. There was a marked increase in the number of disintegrating

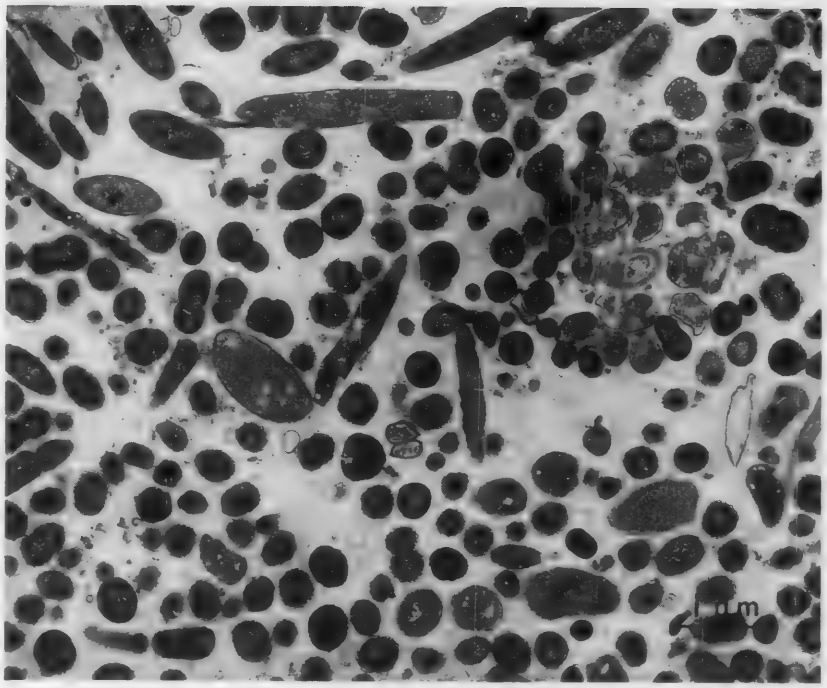

FIG. 5. Electron micrograph of pre-treatment plaque. A localized area of degenerating organisms is in the upper right quadrant (×13,000).

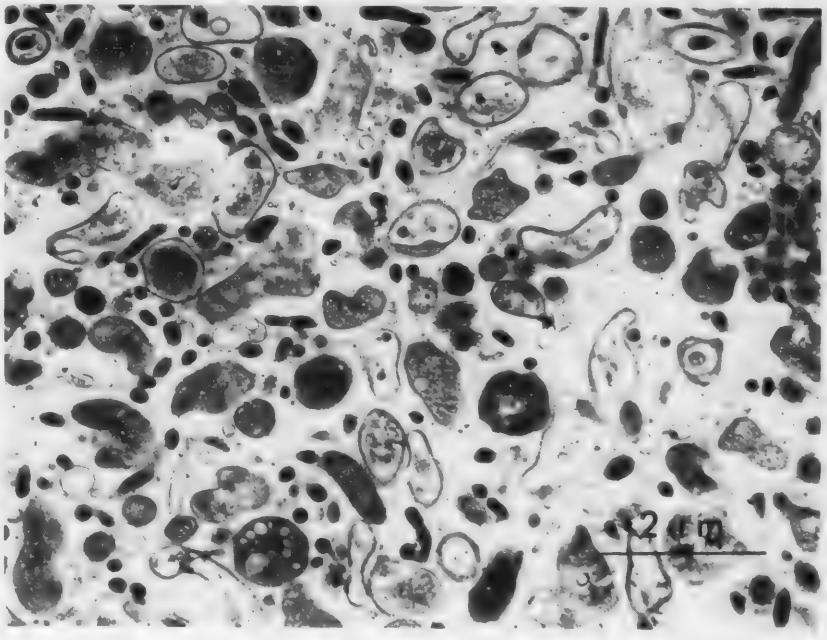

FIG. 6. Electron micrograph of preformed plaque after 5 days of oral rinse regimen with alexidine (×22,750).

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microorganisms in preformed plaque. Figure 6 shows preformed plaque after treatment with QR-711. Most of the microorganisms have lost the intracellular contents, although the cell-limiting structures are visible. The plaque in these micrographs, however, contains an evenly dispersed very small coccal form, densely staining and structurally intact. The same type of coccal forms and some rods are present in other areas of preformed plaque, intermixed with calcified nodules (Fig. 7). A higher magnification of this coccal microorganism is presented in Figure 8 along with a surrounding of lysed bacteria.

The total amount of sample material from new plaque was so small that the entire cross section could be examined with electron microscopy. Sample material of newly formed plaque from two of the patients contained no microorganism. Only epithelial cells, white blood cells and cellular debris were found. Electron micrographs of new plaque that formed during treatment revealed that there was less apparent concentration of lysed or disintegrating bacterial forms, and a much larger scattering of epithelial cells. There was a predominance of small, dense coccal forms intermixed with nests of larger coccoid organisms that occur in clusters of pairs or multiples of pairs (Fig. 9).

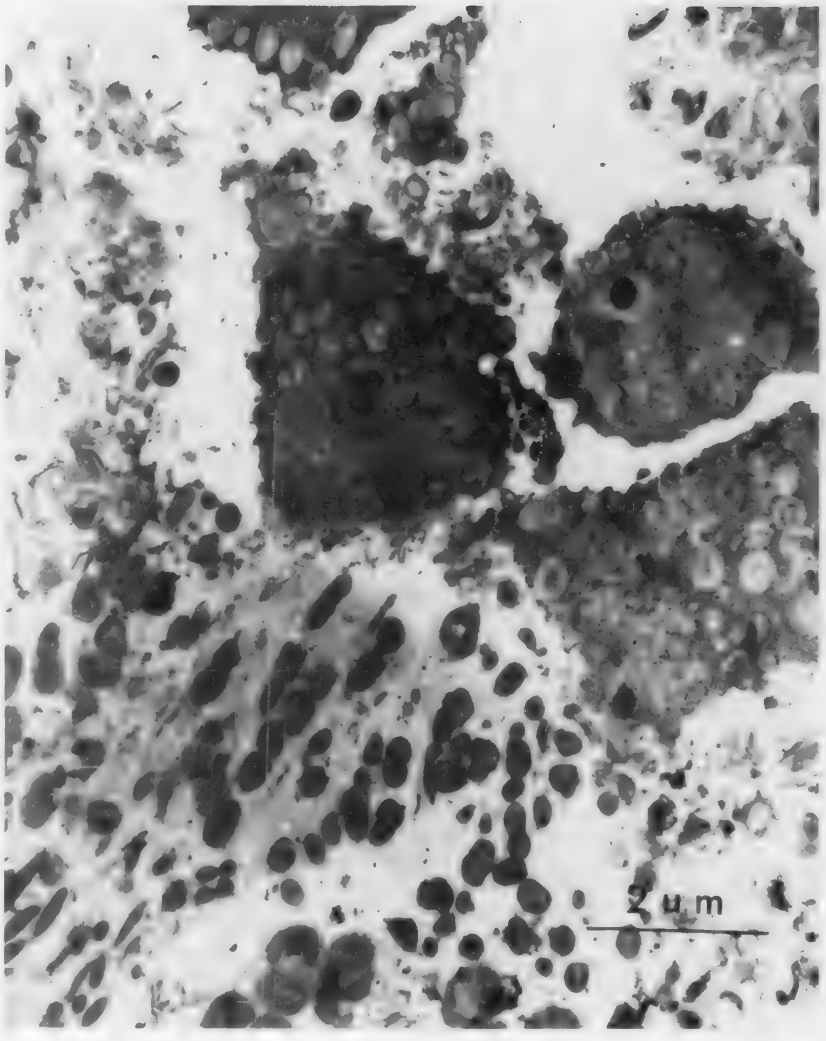

FIG. 7. Electron micrograph of preformed plaque after rinse regimen with alexidine (×24,250).

B. *Biochemical Analysis*

The effect of QR-711 on preformed dental plaque was studied. In comparison with plaque present on the right side at the start of the treatment, a 5-day rinse with QR-711 led to a reduction in preformed plaque wet weight of 55 per cent and in dry weight of 50 per cent (Table 1). Preformed plaque showed a reduction in protein content of 44 per cent after treatment when compared with the plaque on the right side before treatment. When the ratio of the total amount of protein in the plaque to the wet weight of the plaque material is calculated, an increase in this ratio is observed after treatment with QR-711. The weight of protein per wet weight of plaque increased 28 per cent in preformed plaque.

The most notable change after treatment with QR-711 occurred in the soluble alkali extractable proteins of the plaque. The amount of soluble protein per milligram plaque was reduced 87 per cent, equal to a reduction of 90 per cent in the percentage of soluble proteins after treatment with QR-711.

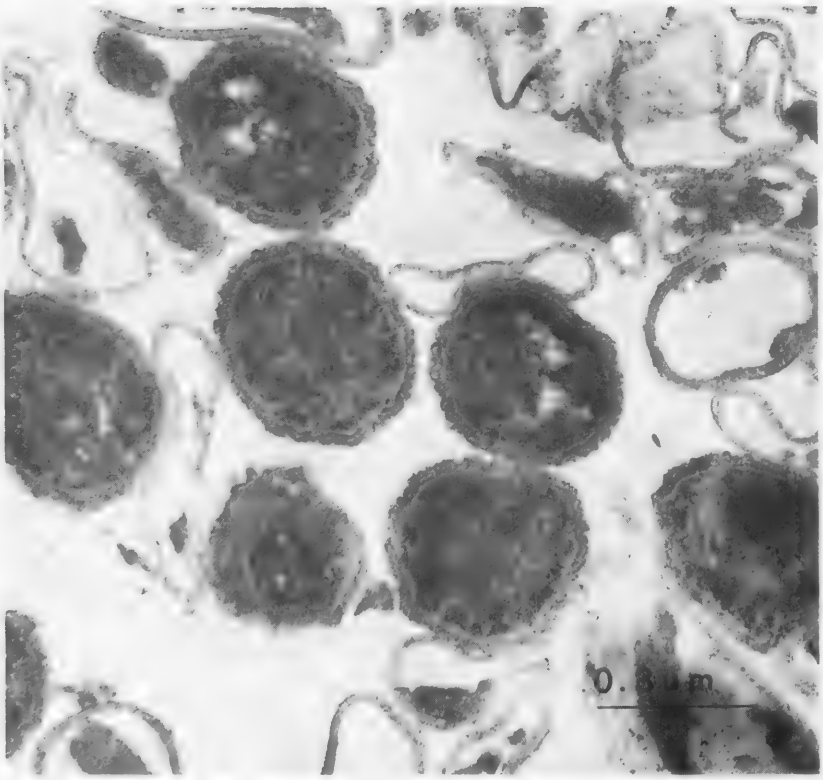

FIG. 8. Electron micrograph of coccal forms in preformed plaque after treatment for 5 days with alexidine (×66,780).

C. *Microbial Analysis*

Results of aerobic incubation on blood agar, which represents the total number of all cultivable microorganisms capable of growth under aerobic conditions, indicate that in 4 out of 6 subject there was a reduction in the concentration of bacteria per milligram of preformed plaque following 5 days of rinsing with QR-711 (Table 2, day 6-left side compared with day 1-right side).

The concentration of bacteria per milligram of the newly formed plaque under the influence of QR-711 (day 6-right side), when compared with existing plaque on the first day (day 1-right side), did not show any consistent changes. Also, there were no consistent differences between right (newly formed) and left side (preformed) plaque on the sixth day.

Anaerobic incubation on blood agar, which reveals the total number of facultative or anaerobic bacteria, has shown on an average 3.0 to 4.7 times higher concentrations of colony forming units than that of the aerobic incubation (Table 2). The proportional changes between one day samples of the right side and 6 day samples of the left and right sides, resembled the changes observed following aerobic incubation. Bacterial concentration per milligram of plaque was reduced consistently only in the preformed plaque following the treatment.

It was assumed that growth on mitis salivarius agar represented all streptococci present in the plaque. There were no consistent differences between left and right side samples pertaining to streptococcal concentration per milligram of plaque. This is true for samples incubated aerobically and anaerobically (Table 3). When the counts of streptococci were compared with counts of all microorganisms in plaque, as determined by cultivation on blood agar, it was found that generally the percentage of streptococci after QR-711 application was higher in the existing and newly formed plaque than in the pretreatment plaque (day 1-right side) (Table 4).

As revealed by anaerobic and aerobic incubation, the percentage of streptococci increased in the newly formed plaque in all subjects. There was also a similar increase in existing plaque on the sixth day of treatment in 4 out of 6 subjects as revealed by aerobic incubation and in 4 out of 5 subjects as revealed by anaerobic incubation.

The number of colony forming units on the mitis salivarius agar under anaerobic conditions was on an average of 2.4 to 2.6 times higher than the yield on the same culture medium incubated aerobically (Table 2).

DISCUSSION

On the basis of electron microscopy observations, there is a change in the content of dental plaque after treatment with QR-711. Most of the areas

of recoverable plaque showed a greater concentration of disintegrating bacterial forms as compared to samples from the same individuals before treatment. These observations may explain the decrease in plaque wet and dry weight, the decrease in cultivable bacteria, and the loss in soluble protein. In addition, certain microorganisms appear to withstand treatment, and to increase in relative concentration in the plaque. The predominance of the small dense cocci and large paired cocci viewed with the electron microscope, especially in plaque newly formed during treatment, may explain the shift in microbial population with QR-711. Species identification, however, cannot be made from electron micrographs. The results of the ultrastructural observations, however, are consistent with the conclusion that QR-711 causes destruction of organisms, leading to lysis, loss of intracellular bacterial protein and cell wall material with a resulting decrease in plaque weight and increased presence of less susceptible microorganisms in dental plaque.

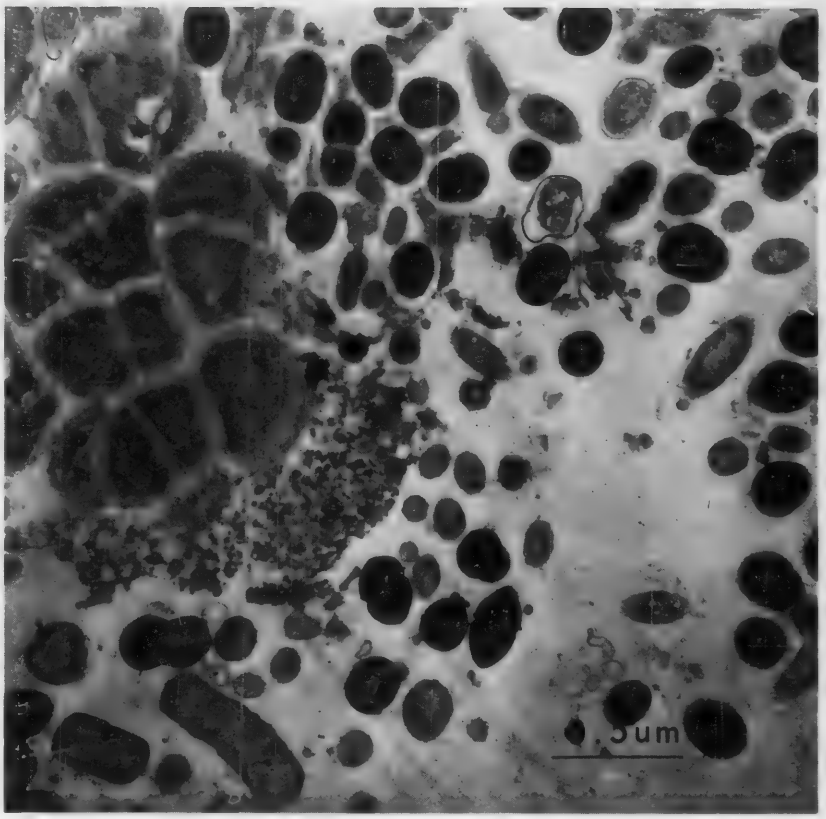

FIG. 9. Electron micrograph of preformed plaque after treatment with alexidine (×17,750).

Table 1. Weight and Protein Content of Preformed Plaque Before and After Treatment with QR-711 (Mean ± Standard Error)

	Day 1 Right Side (Untreated)	Day 6 Left Side (Treated)	% Change
Wet Weight (mg)	19.7 ± 3.1	8.9 ± 2.1	−55**
Dry Weight (mg)	2.6 ± 0.4	1.3 ± 0.3	−50***
Total Protein Content (mg)	734.8 ± 122.2	408.5 ± 99.7	−44**
$\frac{\mu g \text{ Total Protein}}{mg \text{ Plaque}}$	37.7 ± 0.4	48.1 ± 2.5	+28*
$\frac{\mu g \text{ Soluble Protein}}{mg \text{ Plaque}}$	20.0 ± 1.2	2.6 ± 0.2	−87***
% Soluble Protein	53.6 ± 2.2	5.1 ± 0.3	−90***

* P = 0.01 – 0.025.
** P = 0.05 – 0.005.
*** P = 0.001.

The weight and protein analyses show that QR-711 produced marked changes in both the quantity and the composition of the previously formed plaque. The decrease in the total amount of protein present in the plaque is a reflection of such a change. However, when the total protein content present in the plaque after QR-711 treatment is divided by the weight of the plaque recovered, we observe an increase of about 28 per cent *versus* the untreated plaque sample. This could be due to the loss of mucopolysaccharides and dextran and levan components of the plaque as well as the loss of cellular content

Table 2. Concentration of Bacteria in Plaque Before and After Treatment with QR-711.*

Subject	Day 1–Right Side			Day 6–Left Side			Day 6–Right Side		
	Incubation		An/Aer Ratio	Incubation		An/Aer Ratio	Incubation		An/Aer Ratio
	Aerobic	Anaerobic		Aerobic	Anaerobic		Aerobic	Anaerobic	
1	92	880	9.6	100	380	3.8	6.2	22	3.5
2	16	60	3.7	3.4	7.2	2.1	12	34	2.8
3	13	60	4.6	100	780	7.8	30	150	5.0
4	420	1100	2.6	280	400	1.4	18	16	0.9
5	24	140	5.8	9.2	34	3.7	78	280	3.5
6	720	1200	1.7	30	74	2.5	900	2000	2.2
	Mean		4.7			3.5			3.0

* Colony forming units on blood agar per mg of wet plaque × 10^5.

observed in the degenerating bacterial forms. The presence of epithelial cells, bacterial membranes, and the relative increase in coccal forms of bacteria would also tend to increase the relative ratio of total protein to plaque weight samples even though the total amount of plaque and the total protein content have decreased.

The dramatic decrease in soluble, alkali-extractable protein after treatment with QR-711, is probably indicative of a large amount of plaque microorganisms in stages of late cell death[3]. This finding correlates with the large number of degenerating bacterial forms present in the electron micrographs.

Results reported in this study should be interpreted cautiously. The number of subjects on whom the sampling was done was rather small. Also, the variability associated with dispersion of different plaque samples may somewhat affect the results. It appears, however, that such variability in dispersal is minimized when plaque samples from the same subject are analyzed.

The increase in the percentage of streptococci in both the newly formed and existing plaque has been shown in this study. Although a high percentage of streptococci in newly formed plaque could be expected, such an increase in "young" plaque and "old" plaque under the influence of QR-711 is of interest.

SUMMARY

Changes in content of soluble protein, microbiology and ultrastructure of human dental plaque were evaluated after 5 days of a daily one-minute rinse with 0.035 per cent alexidine in 18 per cent alcohol. There were reductions of 55 per cent in plaque wet weight, 50 per cent in dry weight, 44 per cent

Table 3. Concentration of Streptococci in Plaque Before and After Treatment with QR-711.*

Subject	Day 1–Right Side			Day 6–Left Side			Day 6–Right Side		
	Incubation		An/Aer Ratio	Incubation		An/Aer Ratio	Incubation		An/Aer Ratio
	Aerobic	Anaerobic		Aerobic	Anaerobic		Aerobic	Anaerobic	
1	52	150	2.9	36	90	2.5	4.2	12	2.7
2	4.8	14	2.9	2.8	6.8	2.4	6.2	14	2.2
3	7.4	13	1.7	99	98	0.99	29	120	4.1
4	44	150	3.4	220	400	1.8	5.2	4.4	0.8
5	16	32	2.0	3.4	15	4.4	90	200	2.2
6	220	—		24	—		380	—	
	Mean		2.6			2.4			2.4

* Colony forming units on mitis salivarius agar per mg of wet plaque × 10^5.

Table 4. Percentage of Streptococci in the Dental Plaque.

	Day 1–Right Side		Day 6–Left Side		Day 6–Right Side	
	Incubation		Incubation		Incubation	
Subject	Aerobic	Anaerobic	Aerobic	Anaerobic	Aerobic	Anaerobic
1	56.5	17.0	36.0	23.7	67.7	54.5
2	30.0	23.3	82.3	94.4	51.7	41.2
3	56.9	21.7	97.0	12.6	96.7	80.0
4	10.5	13.6	78.6	100.0	28.9	29.5
5	66.7	22.8	36.9	44.1	115.4	71.4
6	30.5		80.0		42.2	

in protein content, and 90 per cent in alkali-extractable protein. There was a reduction in bacterial concentration in preformed but not in newly formed plaque. Streptococci increased in both plaque types. Electron micrographs showed marked destruction of microorganisms, with an increase in the number of dense, small coccal forms.

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Director Appointed for Division of Dentistry

Dr. Sherman L. Cox, a U.S. Public Health Service official for the past 15 years, has been named Director of the Bureau of Health Manpower's Division of Dentistry in Bethesda, Md. Since 1973 he has held positions in the Dept. of Health, Education and Welfare's Region X Office in Seattle, Washington, where he was most recently Chief of the Health Planning and Facilities Branch, Division of Resource Development and before that was Deputy Regional Health Manpower Director. Prior to his Seattle assignment, he was Chief of the Dental Education Branch of the Division of Physician and Health Professions Education in Bethesda, Md.

Dr. Cox served in the Division of Dental Health (as the Division of Dentistry was formerly named) from 1964-69 in various capacities including Special Assistant to the Director and Deputy Chief of the Dental Education Facilities Branch.

A native of St. George, Utah, Dr. Cox received a D.D.S. degree from Baylor University College of Dentistry in Dallas, Texas, in 1958. He also holds a Master of Public Health degree from the University of California, Berkeley. From 1958 to 1960 he practiced dentistry in Grand Junction, Colorado, and worked part time for the Mesa County Health Dept. on Health Program for migrant farm workers.

Dr. Cox has written many articles for professional publications and lectured at the University of Pittsburgh School of Dentistry. Currently, he is Clinical Associate in Community Dentistry at the University of Washington School of Dentistry. He is a Diplomate of the American Board of Dental Public Health, a Fellow of the American Public Health Association, and a member of the American Dental Association, American Association of Dental Schools, and the American Public Welfare Association.

Periodontal Disease Information in College Health Education

Michael S. Goldstein, Ph.D.* and James R. Freed, D.D.S., M.P.H.**

Periodontal disease is an increasingly serious health problem in the United States. However, it is also a disease which is in large part preventable and controllable.[20] This goal can be potentially accomplished through teaching people about the nature of the disease and by motivating them to perform a few simple and repetitive health behaviors. Clearly, health education programs must assume a large share of the responsibility for the achievement of this goal. Recently there has been increased attention paid to evaluating such programs. Most of this research has focused on the question of how effectively and efficiently various programs or techniques convey information. The content of the information presented has been, in a sense, taken for granted. However, the adequacy of the information presented is quite important. It is becoming an even more significant issue as periodontal disease prevention is more and more frequently taking place in settings not controlled by dentists and through educational programs which are developed by people who may have only a peripheral interest in dental health matters. This study will attempt to assess the adequacy of the information on periodontal disease which is provided in one such educational milieu: college level health education curricula.

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METHODOLOGY

This study analyzes only one of a number of media in which health education information regarding preventive dentistry is found: the college or university level health textbook. There are a number of reasons for focusing on this single source of material. First, we are controlling for the effects of analyzing materials which have been prepared for diverse purposes and groups of consumers. We can be reasonably certain that college texts reach a large number of individuals of similar ages (17 yrs.–22 yrs.) in a more-or-less similar environment (classrooms). Second, we can be certain that these texts have been created by professionals who see themselves, and are seen by others, as qualified experts in college health education. Third, these texts deal with health in a comprehensive manner, which is seen as ideal by almost all health educators. Thus, it is possible to see the relative importance health educators place on dentistry relative to other topics. Fourth, textbooks are often the basic building blocks of larger institutional efforts in health education. This is especially the case in areas such as dental health, where the instructors of such courses usually have no special training or background. Consequently, results based on the study of textbooks will have some degree of meaning in terms of understanding the role of dental health education in the content of the larger health education curricula within higher education. In these respects textbooks differ markedly from other media often used by health educators. A final reason for limiting our study to textbooks is the relative ease with which the "population" of texts, as opposed to other health education sources, can be defined. This allows us to be certain of analyzing a fully representative group of materials.

The texts to be included in this study were gathered by combining listings of texts in current

use from a number of sources including *A Directory of References and Resources for Health Instruction* (1969), textbooks for health education instructors, advertisements in professional journals, and correspondence with publishers. We have tried to include *all* college-level general health or hygiene textbooks published between 1966 and 1973. Although we are aware that some books published prior to 1966 are probably still in use, we are excluding them as we wish to focus on the most recent materials available. Only general textbooks are included. That is, books concerned with only one topic or group of topics are excluded, as are books consisting of collected readings. Only the most recent edition of each text has been used. Based upon these criteria, we compiled a list of 20 books to be included in the study.[1–18,20,21]

FINDINGS

We began by examining the texts to see if the structural elements of the mouth which are involved in periodontal disease are described or discussed. We found that the morphology of the supporting structures of the teeth is not covered in most of the texts. The gingiva and periodontal ligament are mentioned in 11 of the texts, alveolar bone in 6, and gingival sulcus in 2. The pulp, dentin, enamel, crown, cementum and roots are all described more often than the most frequently mentioned periodontal terms.

Next a list of 9 terms related to periodontal disease was constructed, and the texts were examined to determine which of the terms are defined, mentioned only, or not mentioned. The results are presented in Table 1. It can be seen that the term "pyorrhea" is still used quite frequently (70% of texts) and is defined as often as the term "periodontal disease." While plaque is mentioned in 13 texts as a cause of dental caries, it is only mentioned in 8 texts in regard to periodontal disease.

Table 1. Use of Terms Related to Periodontal Disease

Term	Defined	Mentioned Only	Not Mentioned
Periodontal disease	12	6	2
Pyorrhea	12	2	6
Gingivitis	11	2	7
Trench mouth, ANUG, etc.	9	2	9
Pockets	9	1	10
Periodontitis	8	1	11
Bone loss	7	4	9
Plaque	6	2	12
Periodontosis	1	0	19

The texts were then analyzed according to when they were published to determine if there are differences in the use of these terms between those books published earlier (1966–70, N = 10) and those published later (1971–73, N = 10). For purposes of this analysis, the "defined" and "mentioned only" groups were combined. We found no important differences between the two groups of texts, with one exception. Contrary to what one might expect, the term "plaque" is found more frequently (6 vs 2) in the older texts.

The texts vary with regard to what they state is the major cause of periodontal disease. The most frequently mentioned major cause is calculus which is cited in 8 texts. A combination of plaque and calculus is given as the major cause in 4 texts; 2 identify plaque alone; 2 give other factors; and 4 texts do not indicate a major cause. There are 26 local and systemic factors which are cited as causes of periodontal disease. The 10 most commonly mentioned are listed in Table 2. There does not appear to be any relationship between how recently a text has been published and whether or not a given cause of periodontal disease is cited.

Eighteen of the texts mention oral hygiene as a method of preventing periodontal disease. However, only 6 texts offer the removal of plaque as the purpose of practicing oral hygiene. Those texts published prior to 1971 mention this more frequently (5 vs 1). Other reasons given for practicing oral hygiene include stimulation of the gums, increasing blood circulation, and removal of food debris. A number of oral hygiene measures are suggested. Those mentioned most frequently are summarized in Table 3.

All 18 texts mentioning oral hygiene recommend toothbrushing. There is some variation in the recommended frequency of brushing. Nine texts recommend brushing "after eating"; seven "after meals"; one "at

Table 2. Ten Most Common Factors Cited as Causing Periodontal Disease

	Cause Periodontal Disease		Not Mentioned	
	No.	%	No.	%
Calculus	14	70	6	30
Bacteria	11	55	9	45
Misaligned teeth	9	45	11	55
Diet	7	35	13	65
Toothbrush trauma	7	35	13	65
Plaque	6	30	14	70
Poor restorations	5	25	15	75
Traumatic occlusion	5	25	15	75
Toothpick trauma	4	20	16	80
Vitamin C deficiency	4	20	16	80

least once a day''; and one text does not make a recommendation. Nine texts make a specific recommendation regarding brushing technique. Only one of these recommends the Bass technique. Seven recommend the roll technique, and one states that brushing should be up and down, not sideways.

There is variation among the 8 texts which make a recommendation regarding the stiffness of the bristles in a brush. Three texts recommend medium; 2 hard; 2 firm; and only one recommends soft bristles. Few books mention the design of the toothbrush. All 5 of the texts recommending a specific size of brush indicate that the head should be small. The 3 texts mentioning the shape of the bristles all recommend that they should be straight across, and one text recommends that the brush should have two rows of bristles. Two of the 9 texts which discuss electric toothbrushes state that they are superior to manual brushes and two state that there is no difference. Four texts indicate that electric brushes are better for some people, while one states that additional studies are needed to determine the relative effectiveness of electric and manual brushes.

Table 3. Oral Hygiene Methods

	Number of Texts				
	"Recommending"	Mentioning	Not Recommending	Not Mentioning	Other
Toothbrushing	18	0	0	2	0
Rinsing with water after eating	12	0	1	7	0
Dental floss	9	2	0	9	0
Dentifrice	8	0	0	11	1
Oral irrigation devices	6	0	0	13	1
Eating fibrous foods	4	0	0	16	0
Toothpicks	2	1	0	16	1
Mouthwashes	0	0	7	12	1

Dental floss is recommended as an oral hygiene measure in only 9 texts and mentioned in 2 others. Detailed instruction in the proper use of floss is given in only 3 texts. This is fewer than the number of texts (4) which mention the dangers of improper use. Only one text states that flossing is of major importance as an oral hygiene measure. No text differentiates waxed or unwaxed floss.

Next to toothbrushing, the most frequently mentioned oral hygiene measure recommended is rinsing with water after eating; although one text states that this is not effective. The method is recommended more frequently in the 1966–70 texts than in those published from 1971–73 (8 vs 4). The role of diet in plaque formation is also mentioned more frequently in the 1966–70 texts (6 vs 3).

In our analysis we examined the texts on 68 specific items. Thirty-two regarded periodontal disease while 36 concerned oral hygiene. As a summary measure of how extensively the texts deal with these topics we totaled the number of items which were coded as ''not mentioned'' for each text. The results for older and newer texts are shown in Tables 4 and 5. As can be seen, there is little difference between the older and newer texts in terms of how much information they contain on periodontal disease and oral hygiene.

DISCUSSION

Our findings reveal that coverage of periodontal disease and oral hygiene in these texts is poor in quality, extent and

depth. In addition, the amount and quality of information varies considerably between texts. Perhaps this is not surprising considering that not one of the texts was authored or co-authored by a dentist. Although there are some examples of information which is simply incorrect, our most important and striking findings are the inconsistency between texts and the almost total lack of attention to certain issues. For example, morphological structures, such as gingival sulcus and alveolar bone, important for an understanding of periodontal disease are not mentioned in most texts. "Pyorrhea" is defined in twice as many texts as the term "plaque."

There is also a very low degree of reliability among the texts regarding such issues as the major cause of periodontal disease, the reason for practicing oral hygiene, the proper frequency and technique of brushing, and the type of toothbrush which should be used. Illustrative of these inconsistencies is the disagreement among texts regarding the value of electric toothbrushes and the fact that the recommended stiffness of toothbrush bristles ranges from hard to soft.

There are numerous examples of facts or issues which are noteworthy in their omission from the texts. The import that these texts place on the area of periodontal disease is perhaps best exemplified by the fact that fewer than half the texts recommend the use of dental floss and only three (15%) give direction on its use.

Finally, our findings reveal that the situation is not improving with the newer texts essentially the same as the older ones. Where differences do exist, such as the use of the term "plaque" or the role of diet in plaque formation, the older texts (1966–1970) present the greater amount of information.

Table 4. Non-Mention of Periodontal Disease Information in the Texts by Date of Publication

Year of Publication	Number of Items Coded "Not Mentioned"			
	10–19	20–29	30–32	Total
1966–70	7	2	1	10
1971–73	6	2	2	10
Total	13	4	3	20

Table 5. Non-Mention of Oral Hygiene Information in the Texts by Date of Publication

Year of Publication	Number of Items Coded "Not Mentioned"			
	10–19	20–29	30–36	Total
1966–70	5	4	1	10
1971–73	5	3	2	10
Total	10	7	3	20

These results have led us to a number of conclusions about periodontal disease education at the college level. The first is that students are not consistently receiving adequate information in this area from their textbooks. Assuming that most instructors of college health courses have no special independent background in this area and thus rely on the texts, our conclusions of inadequacy apply to the courses themselves and not only the textbooks. A second conclusion, by implication, is that the authors of these texts, all professional health educators, are not knowledgeable about periodontal disease and/or do not regard it as an area of import. This is quite significant in that many dental professionals feel that education about periodontal disease and oral hygiene should not take place in isolation, but should be part of a larger health education program. Our findings lead us to beware of this approach, for unless dentists provide stringent quality checks and informational input, the increasing methodological and technical sophistication of health education shall be misapplied.

ACKNOWLEDGMENT

The authors wish to express their appreciation to Ms. Shane Allwright for her assistance.

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The American Academy of Periodontology
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The 61st Annual Session of the American Academy of Periodontology, September 24–27, 1975 in Minneapolis, Minnesota, will highlight two full afternoons of concurrent Continuing Education Courses. Members and guests may choose from eight limited attendance courses on Thursday afternoon and ten on Saturday morning. A new feature of the continuing education program is a mini-self-assessment quiz, mailed along with the meeting brochure, that will outline course content and aid in identifying which courses will be of maximum benefit to the individual.

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Sessions on Construction and Maintenance of a Periodontal Practice, Hard Tissue Reconstruction, and Control of Pain (including the uses of acupuncture and hypnosis) are complemented by projected clinics, research forum, and Balint Orban Memorial Program (a graduate student prize competition).

Attendance at the meeting earns hour-for-hour credit for members of the Academy of General Dentistry. Non-member dentists, graduate dental students and hygienists are welcome on payment of a nominal registration fee (undergraduates admitted without charge). Meeting brochure and registration/reservation forms are available from: The American Academy of Periodontology, 211 E. Chicago Ave. Room 924, Chicago, Illinois 60611.

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Abstracts of Articles in This Issue of the Journal of Preventive Dentistry
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Marcus, M: Comparison of Dentists' Attitudes and Task Delegation Patterns. J Prev Dent 2 (May-June) 1975.

Abstract: Implementation of task reallocation at the practice level is an important issue in the subject of dental auxiliary use. The process of change toward expanded roles for dental auxiliaries involves four stages: a. revisions of state dental practice acts; b. attitudinal changes on the part of dentists; c. training of auxiliaries and implementation; d. appropriate delegation levels achieved by a practice. Six months after the Washington State Dental Practice Act was revised (1971) Koerner and Osterholt conducted a survey in which 55% of the Washington dentist population's attitudes toward task reallocation was obtained. The response rate provides an

Goldstein, MS, Freed, JR: Periodontal Disease Information in College Health Education. 2 (July-August) 1975.

Abstract: This study describes and analyzes the informational content regarding periodontal disease which is contained in college level health textbooks. Content analysis was applied to those portions of all general health textbooks published in the United States from 1966-1973 (N = 20) dealing with the prevention and control of periodontal disease. The results show that the coverage of periodontal disease and oral hygiene in these texts is poor in quality and extent. There is wide disparity among the texts in terms of the orientation and information presented. Important topics are omitted, the validity of the information is often questionable, and inac-

Brady, JM, Gross, A, Grower, MF, Carter, HG, Barnes, GP: Dental Plaque Reduction with an Antibacterial Mouthrinse; Ultrastructural, Microbiological and Biochemical Changes. 2 (July-August) 1975.

Abstract: Changes in content of soluble protein, microbiology and ultrastructure of human dental plaque were evaluated after 5 days of a daily one-minute rinse with 0.035 per cent alexidine in 18 per cent alcohol. There were reductions of 55 per cent in protein content, and 90 per cent in alkali-extractable protein. There was a reduction in bacterial concentration in preformed, but not in newly formed, plaque. Streptococci increased in both plaque types. Electron micrographs showed marked destruction of microorganisms, with an increase in the number of dense, small coccal forms.

Abstracts (Continued)

curate statements are made. There is no improvement in the information presented when the newer texts (1971-1973, N = 10) are compared to those published earlier (1966-1970, N = 10). These findings indicate that information regarding the prevention and control of periodontal disease in college level health education is inadequate and that dental health educators should carefully examine general health education programs to insure the quality of the dental health component.

indication of the second stage. From October 1974 through September 1974 patterns of task delegation were obtained for 18 Washington practices through a UCLA manpower study. These data provide an indication of the third stage. This paper compares the attitudinal survey to actual task delegation patterns based on seven delegable tasks common to both studies. Insight is thus gained into the transitional phase between positive attitude and implementation.

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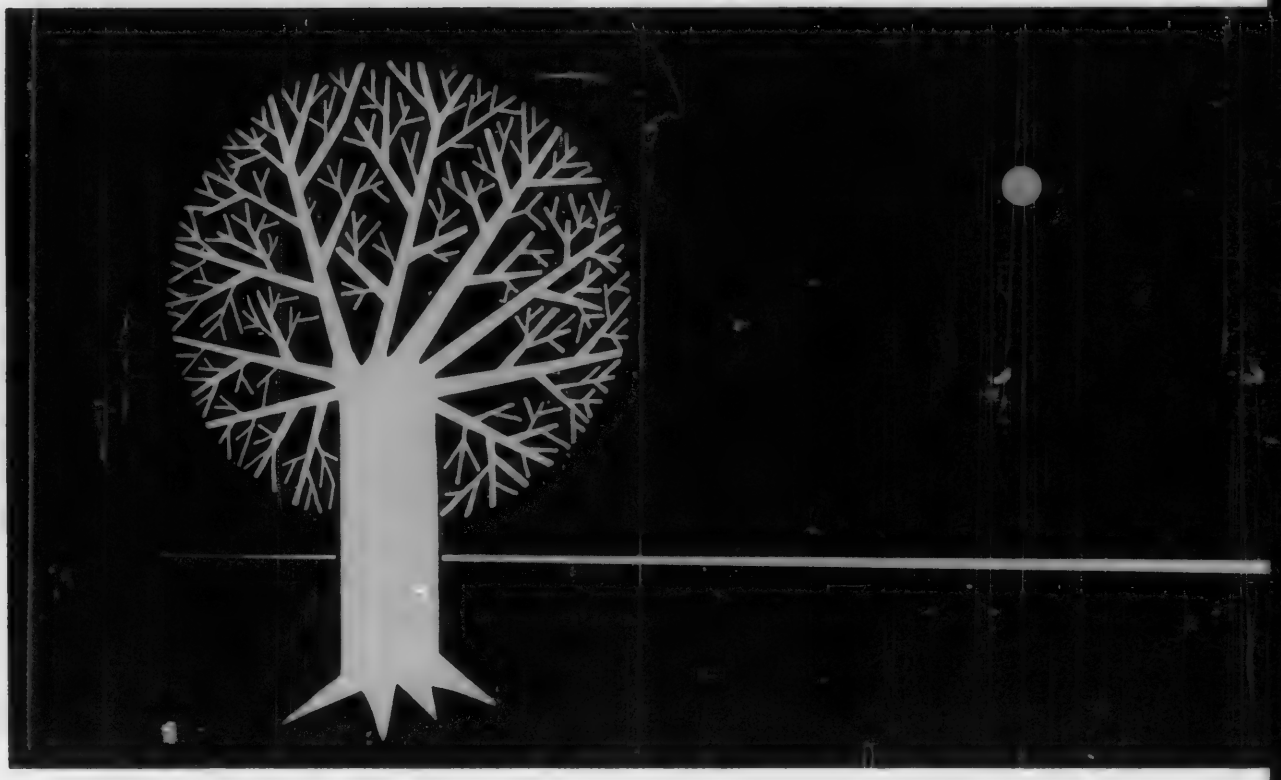

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Effects of Cetylpyridinium Chloride Containing Lozenges on Dental Plaque and Gingival Bleeding

George P. Barnes, D.D.S., M.S.D.*, William H. Radentz, D.D.S., M.S.D.** and Beverly E. Perkins, B.S.***

Organized dentistry has generally accepted the role of bacterial plaque as a major etiologic factor in dental disease. While reports[2,4,10–14] indicate that there are various experimental agents which demonstrate excellent potential as plaque inhibitors, for a variety of reasons, several years may elapse before a new anti-plaque drug is available to patients and laymen in this country. Therefore, recent interest has been focused upon commericially available products in an effort to determine their potential as plaque inhibitors. At least three reports[3,8,17] have indicated that use of a commercial mouthwash containing cetylpyridinium chloride and domiphen bromide will clinically reduce gingivitis and/or decrease plaque deposition. Ciancio, *et al.*[7] reported that another mouthwash containing only cetylpyridinium chloride significantly prevented plaque accumulation. Furthermore, a recent series of investigations[6] revealed that daily use of the latter cetylpyridinium chloride mouthwash significantly reduced existing plaque deposits on the teeth.

While mouthwashes containing cetylpyridinium chloride have been demonstrated to partially inhibit plaque formation, it might be more convenient for patients to use the agent if it could be incorporated in a different vehicle without loss of plaque inhibitory efficacy. Therefore, the specific purpose of the study reported in this paper was to determine the clinical effects of commercially available throat lozenges containing cetylpyridinium chloride on existing plaque deposits and the effect of these lozenges toward the inhibition of new plaque formation. A secondary purpose was to determine what effect, if any, these lozenges might have on gingival sulcular hemorrhage.

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METHODS AND MATERIALS

A total of 97 enlisted military personnel volunteered to serve as subjects in this study. Of that number, 91 completed all of the procedures involved in the investigation. The subjects completing the study ranged in age from 17 to 49 years, with a mean age of 24.8 years. A total of 76 of the subjects were males and the remainder were females. Included were 77 Caucasians and 14 non-Caucasians. Potential subjects with more than 8 missing natural teeth were excluded from the study.

All subjects received an initial examination for gingival hemorrhage using the Gingival Bleeding Index described by Carter and Barnes[5]. In this study, the index was modified to the extent that only the maxillary and mandibular left quadrants were examined. Immediately following the Gingival Bleeding Index examinations, the subjects were required to rinse their mouths for 60 seconds with 20 ml of a plaque disclosing solution (an aqueous solution of 3.0% basic fuchsin in ethanol). Following this, each subject was examined for bacterial plaque using the index of Quigley and Hein[15]. The examinations for gingival hemorrhage and plaque were conducted by separate examiners. The subjects were prohibited from performing any oral hygiene procedures immediately prior to their examinations.

Following their initial examinations, the subjects received a dental prophylaxis and sub-

Table 1. Factors of Age, Sex and Race of the Subjects in the Study

Group	Total Number Subjects	AGE		SEX		RACE	
		Range	Mean	Male	Female	Caucasian	Non-caucasian
A	32	17–33	23.0	29	3	27	5
B	31	18–45	24.5	27	4	28	3
C	28	19–49	27.3	20	8	22	6
All Groups	91	17–49	24.8	76	15	77	14

gingival scaling of the right maxillary and mandibular quadrants. This treatment included interproximal flossing and the use of erythrosin stain to insure complete removal of all plaque.

Based upon the results of the baseline plaque examinations for the entire dentition, the subjects were stratified and assigned to one of three groups of correspondingly equal mean plaque scores. Initially, the three groups contained 32, 33 and 32 subjects; respectively. On the day following their initial examinations and prophylaxes, the subjects in Group A were issued a 6-week supply of throat lozenges containing cetylpyridinium chloride (1:1500) and 0.3% benzyl alcohol*. They were instructed to use three lozenges per day (in the morning, at noon, and in the evening) for the six-week study period. When using the lozenges, they were further instructed not to chew them, but to allow them to slowly dissolve in the mouth and to swish the material so as to cover all tooth surfaces. The subjects in Group B received the same throat lozenges and instructions as the Group A subjects with the following exception. They were instructed to use only one lozenge daily (in the morning) during the six weeks of the study. The subjects in Group C served as controls and received no lozenges. In order to insure compliance with the study requirements, the lozenge therapies rendered to the individuals in Groups A and B were supervised by the subjects' military supervisors. All subjects were instructed to continue their normal home oral hygiene procedures without change, except that mouthwashes and lozenges containing cetylpyridinium chloride, other than as assigned, were prohibited. During the study the subjects were prohibited from receiving prophylaxes and scalings, except for those previously mentioned.

Six weeks following the first day of lozenge therapy, all of the subjects received second examinations for gingival bleeding and dental plaque. The final and initial examinations were conducted in an identical manner by the same examiners, who were not informed as to the composition of the groups and the experimental therapies received by the various subjects.

Upon completion of the study, the following data was tabulated for the subjects in each of the three groups: (1) the initial examination mean plaque scores for the entire dentition; (2) the initial and final examination mean plaque scores obtained on the right side (side receiving prophylaxis); (3) the initial and final examination mean plaque scores for the left side (side not receiving prophylaxis); and (4) the initial and final examination mean gingival bleeding scores obtained on the left side. For each group, incremental differences in mean plaque and bleeding scores were calculated and the changes were expressed as percentages. All incremental differences within the groups and between the various groups were statistically analyzed using Dun-

* Cepacol Throat Lozenges, manufactured by Merrell-National Laboratories; Division of Richardson-Merrell, Inc., Cincinnati, Ohio 45215.

Table 2. Plaque Scores for the Entire Dentition at the Time of Initial Examinations

Group	Number Subjects	Daily Lozenge Dosage	Initial Entire Dentition Mean Plaque Scores ± S.D.
A	32	3	1.30 ± 0.45
B	31	1	1.32 ± 0.52
C	28	None	1.36 ± 0.53
Probability of difference between groups			N.S.

Table 3. Effects of Cetylpyridinium Chloride Lozenges Toward the Inhibition of New Plaque Formation: Data Collected on Teeth Receiving Prophylaxis and Scaling

Group	Number Subjects	Daily Lozenge Dosage	Mean Plaque Scores ± S.D.		
			Initial Exam	After Prophy	Final Exam
A	32	3	1.31 ± 0.48	0.00	1.16 ± 0.46
B	31	1	1.34 ± 0.59	0.00	1.24 ± 0.49
C	28	None	1.38 ± 0.52	0.00	1.36 ± 0.48
Probability of differences between groups			N.S.		N.S.

nett's "t" test[9], analysis of variance[16] and Scheffé's Method for Multiple Comparisons[16].

RESULTS

Information concerning the factors of age, sex and race of the study subjects is presented in Table 1. Table 2 depicts the data concerning the entire dentition plaque scores, for the various groups, at the time of initial examination. Data concerning the changes in mean plaque scores on the right and left sides of the mouth, for the three groups, are related in Tables 3 and 4, respectively. Table 5 presents information concerning the changes in gingival bleeding scores for the different groups. Data is presented only for those subjects completing all of the study procedures. Included in this category were 32 subjects in Group A; 31 in Group B; and 28 in Group C.

DISCUSSION

The original design of this study included an additional group of subjects with a daily lozenge dosage of two per day. Unfortunately, an insufficient number of individuals volunteered to serve as study subjects, precluding the inclusion of this group. However, the results obtained in the investigation indicate that a group of subjects using two lozenges per day was unnecessary. Neither the use of one cetylpyridinium chloride lozenge, nor the use of three lozenges per day resulted in a significant change in clinical plaque scores. In analyzing the data collected on the teeth receiving prophylaxes and scalings, the mean plaque scores exhibited by the three groups were not significantly different, neither at the time of initial examination nor upon final evaluation. Considering the data collected on the teeth which did not receive a prophylaxis, the control group subjects experienced a 3.7 per cent improvement in plaque scores; the subjects receiving one lozenge per day exhibited a 7.0 per cent plaque reduction; and those individuals using three lozenges daily experienced a 9.3 per cent reduction in plaque. However, neither the within-group changes, nor the incremental differences between the groups, were statistically significant. Thus, the dosage levels of cetylpyridinium chloride lozenges used in this study were equally ineffective in reducing existing plaque accumulations and in inhibiting new plaque formation. While it is possible that much higher dosage levels might have significant plaque inhibitory effects, long-term patient compliance with such a program may be impractical.

In this investigation, the Gingival Bleeding Index examinations were conducted exclusively on the left side of the mouth, because it was believed that the prophylaxis and scaling therapy performed on the right side would, of itself, affect changes in bleeding scores. The data obtained using the Gingival Bleeding Index was similar to the results of the plaque evaluations. The three groups experienced changes in gingival bleeding of +7.4 per cent, −5.7 per cent, and −4.5 per cent. However, none of the incremental differences were statistically significant. Hence, the daily usage of one, or three, cetylpyridinium chloride lozenges had no significant effect on gingival hemorrhage.

It is interesting that the lozenges used in this study were ineffective, while mouthwashes containing cetylpyridinium chloride previously have exhibited plaque and/or gingivitis inhibitory effects[3,6–8,17]. While insufficient daily dosage may

(Continued on page 6)

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[1]Torell, P., and Ericsson, Y., *Acta Odontologica Scandinavica 23* :287, 1965. [2]Rugg-Gunn, A. J., Holloway, P. J., and Davies, T. G. H., *British Dental Journal 135*: 353, 1973. [3]Aasenden, R., DePaola, P. F., and Brudevold, F., *Archives of Oral Biology 17*: 1705, 1972. [4]Brandt, R. S., Slack, G. L., and Waller, D. F., *Proc. British Paedodont. Soc. 2*:23, 1972. [5]Forsman, B., *Community Dent. Oral Epidemiol. 2*:58, 1974. [6]Heifetz, S. B., Driscoll, W. S., and Creighton, W. E., *JADA 87* :364, 1973. [7]Horowitz, H. S., Creighton, W. E., and McClendon, B. J., *Archives of Oral Biology 16*: 609, 1971. [8]Koch, G., *Odont. Revy. 18*: Supplement 12, 1967. [9]Moreira, B. H. W., and Tumang, A. J., *Rev. Bras. Odont. 173*:37, 1972.

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Table 4. Effects of Cetylpyridinium Chloride Lozenges on Existing Plaque Deposits: Data Collected on Teeth Not Receiving Prophylaxis

Group	Number Subjects	Daily Lozenge Dosage	Mean Plaque Scores ± S.D.		Changes Within Groups		
			Initial Exam	Final Exam	Incremental Difference	Percentage Change	P.
A	32	3	1.29 ± 0.46	1.17 ± 0.47	0.12	9.3%	N.S.
B	31	1	1.29 ± 0.49	1.20 ± 0.38	0.09	7.0%	N.S.
C	28	None	1.34 ± 0.56	1.29 ± 0.51	0.05	3.7%	N.S.
Probability of differences between groups			N.S.	N.S.			

partially explain the results of the current study, a second reason for the lozenges' lack of efficacy might be related to their ingredients additional to cetylpyridinium chloride. Although the complete formulation of the lozenges used in this study is unknown, chemical analysis in our laboratory indicated that they contain sucrose or a similar sugar. This information was verified by a distributor of the product[1]. If cetylpyridinium chloride lozenges could be formulated without sucrose or a similar sugar, it is possible that the resultant product would partially inhibit bacterial plaque accumulations. Considering the results obtained with cetylpyridinium chloride mouthwashes, investigation of this possibility might be warranted.

SUMMARY

The specific purpose of this examiner-blind clinical study was to determine the effects of commercially available throat lozenges containing cetylpyridinium chloride on existing dental plaque accumulations, new plaque formation and gingival sulcular hemorrhage. A total of 91 adult subjects, who had been divided into three groups, completed the study. For a period of 6 weeks, the subjects in Group A received three cetylpyridinium chloride lozenges daily; Group B received one cetylpyridinium chloride lozenge per day; and Group C served as controls and received no lozenges. Those subjects using lozenges were instructed to allow the product to slowly dissolve in the mouth rather than to chew it. To insure compliance, all lozenge therapy was supervised. With the exception of the initial professional cleansing, the subjects were prohibited from further dental prophylaxes and the use of cetylpyridinium chloride containing products, other than as assigned, for the duration of the study. All subjects received identical pre-test, post-test examinations to determine their plaque and gingival bleeding scores. Comparison of the results of the initial and final examinations revealed that neither of the three groups experienced any significant changes in plaque or gingival bleeding scores.

Based upon the data obtained under the conditions of this experiment, the daily use of commercial lozenges containing cetylpyridinium chloride appears to be ineffective in reducing existing bacterial plaque accumulations, inhibiting new plaque formation, and reducing gingival

Table 5. Effects of Cetylpyridinium Chloride Lozenges on Gingival Bleeding Scores

Group	Number Subjects	Daily Lozenge Dosage	Mean Number Scoreable Areas	Mean Number Bleeding Areas		Changes Within Groups		
				Initial Exam	Final Exam	Incremental Difference	Percentage Change	P
A	32	3	11.0	2.5 ± 2.44	2.7 ± 2.21	+0.2	+7.4	N.S.
B	31	1	10.5	3.5 ± 2.94	3.3 ± 2.19	−0.2	−5.7	N.S.
C	28	None	10.4	2.2 ± 2.04	2.1 ± 2.04	−0.1	−4.5	N.S.

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The Chewing Stick

Its uses and Relationship to Oral Health

Joel L. Manley, D.D.S.*, William A. Limongelli, D.D.S.**, and
Arthur C. Williams, D.D.S., M.P.H., M.S.†

Recent experience with several patients, native to West Africa, have caused us to develop at least an unsettling interest in the use of the chewing stick or sponge as a means of achieving a higher level of oral hygiene.

The chewing stick is a soft wood stick taken from either a tall, far spreading tree with white bark and medium sized leathery leaves (Terminalia Togoensis) or from a smaller tree with brown bark and partly ovate leaves (Terminalia glaucescens). The chewing stick derived from the latter named tree is obtained by isolation of the roots.[1]

Research informs us that, throughout Africa, south of the Sahara, the chewing stick has been a traditional method of cleaning the teeth. Among the Yoruba people, the major tribe in Western Nigeria, the chewing stick or sponge has taken on meaning that extends beyond the purpose of its inception. Ajisafe[2], in his explanation of the customs of the Yoruba people, indicates the broad extent to which this instrument has taken on a symbolic meaning far in variance to its original purpose. Specifically, when a man dies and his widow mourns for him, a prospective second husband sends this woman his chewing stick as a symbol of his love for her.

CASE REPORT

Our interest in the chewing stick was prompted by a 29-year-old Ghanaian female patient who was seen at our clinic with the chief complaint of a stain on her tooth. The trivial nature of this complaint, in the setting of our inner city practice and the patient's virtually clean mouth (Fig. 1), came as a pleasant surprise to us. We inquired as to the method the patient was using to maintain her excellent oral hygiene. Her response came as the second statement in a chain of surprises. She explained that she did not brush her teeth, but had always used a chewing stick. Our exposure to this implement of oral hygiene had always been limited throughout our dental education. We decided to thoroughly analyze this patient's oral habits in an effort to compare this method of oral hygiene with those of sulcular brushing. During the patient's initial visit, we removed a small stain from the mesio labial surface of her upper left lateral incisor during the course of a complete prophylaxis. The maxillary anterior crowding, which existed to a slight degree, was felt to be the main contributing factor. A periodontal examination revealed all existing teeth in both the maxilla and mandible to be free of calculus and plaque, with a sulcular depth of 1.5 to 3.0 mm throughout.

Radiographic examinations consisting of panorex film and four bite wings revealed all teeth to be caries free, with optimal alveolar bone levels and exhibiting a normal trabecular pattern. No pathologic findings were noted.

The patient was allowed to express first hand, her involvement with use of the chewing stick as well as a relatively complete description of her daily dietary habits in an effort to isolate the pertinent factors responsible for her oral health status. She stated that she had seen a dentist only once in her lifetime prior to her present visit. This event took place 12 years previously, for extraction of the lower left first molar due to caries. Other than this solitary finding, she denied any other oral discomfort including bleeding, sorenesss or tooth sensitivity. With regard to her overall physical status, she admitted to an annual physical examination, the last of which was within the past 6 months. This had been a common practice of her family since her early childhood. She claimed to

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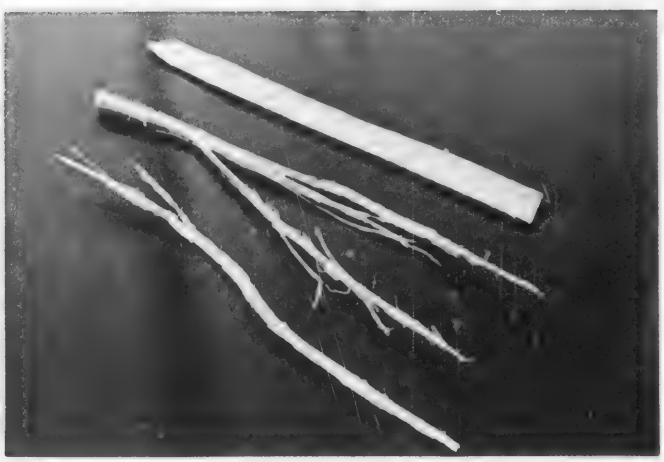

FIGS. 1 and 2. (Top) Healthy intra-oral appearance of patient, attributable to use of the chewing stick. Note small stain apparent on mesio labial surface of upper left lateral incisor which was chief complaint. (Bottom) Chewing sticks used by this patient. Sponge is fashioned from stick (top) by shredding (center and bottom), and rolling shreds into a ball with the fingers.

have always been in good health, denying any previous illnesses or operations, with a pregnancy 5 years ago as the only positive finding.

Her parents were native West Africans. Her father died 4 years previously due to a stroke. The patient's mother stated that at the time of his death, he had a perfect dentition with a full compliment of teeth, no cavities and no fillings. Her mother admitting to losing four teeth due to decay and admitted to a practice of holding tobacco in her mouth (snuff dipping). Clinical examination of the mother revealed a healthy periodontal status with several interproximal areas of tobacco stain as the only remarkable finding. Her mouth was caries free.

The social history was non-contributory with the patient denying having ever smoked or used alcoholic beverages.

In response to our request, the patient outlined the details of her dietary pattern. Her breakfast begins at 7:00 A.M., consisting only of coffee or tea, plain without sugar. Lunch usually begins at 1:00–2:00 P.M. consisting mainly of soup and cornmeal or beef stew. Supper usually begins at 8:00 P.M. with the following comprising the basic constituents of this final meal of the day; Green plantain, soup, beef stew and beef bones, onions, tomatoes, green vegetables, crab and fish. The only fried food she admitted to was chicken which would be served once or twice a month. The pa-

tient would prepare all of the food that she and her family eat just as her mother had done during her childhood.[3] She mentioned that between meal snacks did not exist as a part of her family's dietary regimen, with very few exceptions. When there was a desire for food at times other than mealtime, fresh fruits or a muffin replaced such American favorites as cake or candy.

The patient then showed us the chewing stick, describing it and its use (Fig. 2). The sponge, we discovered, was produced from shredding the stick. The patient stated that upon arising each 6:30 A.M., she would first rinse her mouth with water and then chew this sponge for 20 to 30 minutes. Following this, she would take the sponge in her fingers and scrub her teeth and gums. She would then dispose of the sponge and rinse her mouth once again with water. She would repeat this process before retiring to bed at night. She would occasionally use the stick itself, very much like a tooth brush but preferred the sponge. Her 4-year-old son was also well grounded in these oral habits and demonstrated excellent oral hygiene on clinical examination. The child was breast fed as an infant until he could walk, as are the vast majority of children in her native land. After this, he was placed directly on an adult diet. Baby foods, she explained, are not part of her culture and are not really necessary.[4]

DISCUSSION

After consideration of the interview with this patient and an analysis of her way of life, diet and family background as well as consideration of current oral hygiene methods in the United States, we have mixed emotions about making specific statements regarding the benefits of the chewing stick or sponge. We feel that this patient and her family have benefitted, as have many others, from its use but more extensive analysis of the effects of diet are necessary in order to clearly isolate the specific benefits of this device. We feel also that Dr. Karl Wenle[5], in his study of native life in East Africa, is correct in hesitating to ascribe additional abilities of these people to resist physical debilitation because of their customs or cultural patterns. It is of interest however, that East African peoples do use the chewing stick as opposed to the tooth brush and do seem to maintain healthy oral structures for a longer period of time than Americans. The problems of greatest difficulty in relating oral health to the chewing stick are compounded not only by the carbohydrate content in the diet but also by the manner in which the chewing stick is used. Specifically, we should take note that the chewing sponge is used over a considerably longer period of time than the average tooth brush user spends during each daily procedure. We should note further that the chewing stick or sponge, in particular, has a broad variation in stiffness and strength between initiation and completion of the procedure. Additionally, it is used in two different ways—first through chewing and finally by scrubbing, with the sponge held by the fingers.

It is apparent that a true comparison of the merits of the chewing stick or sponge as opposed to those of the tooth brush is not an easy task. One of the most important points in an evaluation of any oral hygiene device deals with the degree to which gingival sulci, in general, and interproximal sulci, in particular, are cleansed by the aid.

Evaluation must also take into account a setting of widely variant cultural patterns including differences in dietary intake of both carbohydrate and fibrous foods, all having a marked effect on the oral hygiene.

It is our hope that further work will be done in determining the attributes of the chewing stick as we suspect this will result in further progress in the fight against periodontal disease in the United States.

SUMMARY

The chewing stick or sponge is the principal implement of oral hygiene of the natives of Africa and other countries. It has been used with great success in its contribution to oral health. A history of its usage, past and present, is brought to light through interview with a patient employing this device. A discussion of dietary and cultural differences is included.

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Public Acceptance of Dental Preventive Measures

S. Stephen Kegeles, Ph.D.*

Recent publications[22,31] have provided summaries of research which indicate impressive progress during the last decade in developing new preventive measures for oral diseases. Chapters in a monograph about to be published[28] suggest that new means may be available shortly for the mass prevention of dental caries and periodontal disease. The goal of these efforts is to prevent oral diseases in the world population. However, unless people are willing to use the measures developed, this goal will not be met. This problem faces the health establishment whenever biological and/or chemical research is finally successful.

This paper attempts to provide an analysis of factors which need consideration if the population is to accept new dental preventive measures, and analyzes the possible effects of using certain strategies for achieving their acceptance.

This analysis will be carried out in the following order: (1) assessment of factors relevant to degree of acceptance of current dental preventive methods; (2) likelihood of acceptance of new preventives if distributed in different forms; and (3) potential strategies for obtaining acceptance of new preventives.

Throughout the paper, attempts will be made to indicate limitations of current research data.

REASONS FOR ACCEPTANCE OF CURRENT MEASURES BY THE POPULATION

Three major means for preventing dental caries and periodontal disease have been recommended to the public by the dental profession: (1) community water fluoridation; (2) periodic and regular visits to dentists; and (3) self-maintenance activities including restricting or supplementing diets, and brushing or using other mechanical procedures for removing the immediate causes of caries or periodontal disease. Analysis will be provided of each of these measures to determine their relevance to the acceptance of new dental procedures.

1. *Community water fluoridation*

The most recent data indicate that almost half of the United States population, and a much smaller proportion of the world population, does not drink water which contains an optimal level of fluoride.[9]

Research directed toward understanding the failure of attempts to fluoridate community water supplies in the United States was carried out by a large number of social scientists, including psychologists, sociologists, political scientists, anthropologists and psychiatrists during the late 1950s and early 1960s. Excellent summaries of this research have been provided.[5,12,25,30]

A major explanation of the failure of fluoridation appears to lie in the ability of "anti-fluoridationists" to create controversy on: (1) the effectiveness of community fluoridation in reducing caries; (2) the danger of fluoridation to health; and (3) the invasion of rights of the populace to decide its own fate if community fluoridation is instituted. The controversy occurred whether the community decision was made through popular referendum or through executive edict. Certain forms of government (those which

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acted with the least amount of citizen participation) were most successful in achieving fluoridation. Thus, communities with single party domination or with mayors who had held office for long periods of time quite frequently instituted fluoridation. Communities with non-partisan government and those in which citizens were asked to vote frequently on local issues instituted fluoridation infrequently. However, whether or not fluoridation was eventually accepted within U.S. communities, the controversy engendered seems to adversely affect neighboring communities.

For a decade, the adoption rate of fluoridation remained at 35–40 per cent in U.S. communities in which it was deliberated. Beginning in the middle 1960s, local legislative and executive bodies became occupied with other issues within their communities. Over the past 5 years few efforts have been made to achieve fluoridation locally.

Promotion of fluoridation on a total state basis with mandatory local fluoridation was pioneered by Hirakis and Foote[16] in Connecticut. Statewide fluoridation was legislated in 6 additional states. However, new state fluoridation legislation has not swept the United States. Thus, it appears to the author that efforts to promote new dental preventive measures in U.S. communities in which decisions for their acceptance must be made by popular vote or by elected officials will not be successful.

Current Status Of Preventive Activities By The Population. Prior to reviewing literature on reasons for other preventive behavior of the population, data are needed on the current status of these activities.

2. *Routine And Periodic Visits To Dentists For Preventive Reasons*

The means most widely recommended for primary and secondary prevention of dental caries and of periodontal disease are routine periodic visits to dentists. The most recent data indicate that about 46 per cent of the United States population visits a dentist at least once a year.[26] However, a much smaller proportion (about 15–20%) visits dentists on a routine periodic basis.

There is a direct relationship between amount of income, amount of education and level of occupation, and both frequency of dental visits and frequency of routine, periodic visits. Fewer overall dental visits and fewer routine visits are made by (1) members of minority groups rather than those of the white majority; (2) older persons rather than those under 45; and (3) rural rather than non-rural inhabitants.

3. *Activities Carried Out At Home*

At various times, the U.S. population has been urged by the dental profession to reduce consumption of carbohydrates and sweets, to reduce frequency of eating, to use dietary additives, to brush teeth and gums and to use toothpicks and floss in order to prevent and/or reduce dental decay and periodontal disease. How many people follow these recommendations? Few data are available on frequency of carbohydrate restriction or on use of dietary additives. These activities seem to be practiced by only an extremely small portion of the population. An extremely small portion of the population probably uses dental floss, toothpicks or other periodontal aids as well.

Brushing is the single home dental preventive activity followed by a large portion of the population. It is claimed to be carried out at least once a day by about 60 per cent of the population and more than once a day by about 30 per cent. According to 1965 data, about 35 per cent of the U.S. population claim to use a fluoride toothpaste for brushing.[4] According to 1973 data, about 2/3 of all toothpaste sold in the U.S. contains fluoride.[34] However, data later than 1965 do not seem to be available on the per cent of people who use fluoridated toothpaste. Brushing seems to be practiced more by women than men; to a greater extent by the highly educated than by those with grammar school education or less; to a greater extent by those earning high incomes than by those earning less.

In order to prevent dental disease on a mass basis, a much larger portion of the population must use new preventives. If we can determine why current activities are not followed by more people, we may have valuable leads about methods for the delivery of new preventive measures.

FACTORS IN POPULATION WHICH MAY REDUCE PREVENTIVE DENTAL ACTIONS

1. *Periodic Dental Visits*

Kegeles[20] summarized research findings on social and psychological characteristics which differentiate persons who visit dentists for routine periodic purposes from those who do not. Only one set of factors has been replicated in a number of studies: persons who make routine, periodic visits (1) believe themselves vulnerable to serious dental disease and (2) believe periodic visits reduce their likelihood of having serious dental problems. These beliefs are held to a much lesser extent by persons who do not make routine, periodic dental visits.

A number of investigators[10,17,18,23] have tried to determine other belief factors, which discriminate among persons who make routine dental visits and those who do not. Among these factors are (1) perceived seriousness of dental disease, whether defined as clinical seriousness, as interference with activities regarded as important by respondents, or as reducing appearance of respondent, (2) perceived importance or salience of dentistry, (3) fear of pain of dentistry, (4) anxiety about dental office procedures, (5) perceived cost of care, (6) perceived characteristics of dentists.

This is not intended to indicate that these beliefs are unimportant. Rather they have not yet been demonstrated to provide consistent differences between persons who make routine dental visits and those who do not.

2. *Control of Diet*

As indicated earlier, no data seem to have been collected systematically which indicate differences among persons who have changed their diets in order to reduce caries and those who have not.

Since data concerning control of diet for dental purposes are not available, we must turn to the medical literature for information.

Maintenance of diet to reduce or control weight seems difficult.[7] Receiving instructions from physicians or nutritionists, being a member of a weight reduction group or receiving rewards for losing weight, each appears successful in diet control for certain people for short periods of time. However, most people appear to revert to their customary eating patterns, no matter which procedure is used.

Maintenance of sodium restricted diets following heart attacks or of acid-restricted diets following stomach ulcer or colitis also seems difficult. In their study of compliance among high-risk cases for heart disease, Heinzelman and Bagley[15] found that neither experimental (group discussion) nor control group maintained dietary restriction over a one-year period.

On the other hand, Croog and Levine, in as yet unpublished data, found that over two-thirds of men who had been hospitalized for first myocardial infarctions claimed to maintain prescribed diets for up to a year. Approximately the same percentage claimed to maintain prescribed diets by their physicians.

3. *Toothbrushing*

The review by Kegeles[20] related the following factors to frequency of brushing: (1) belief that brushing is an effective means for reducing tooth decay; (2) habitual patterns of brushing started during childhood, (3) for older children, concern about appearance of teeth. However, these beliefs appear easy to change. They may serve only as rationalizations to explain behavior which has become routine and habitual.

Much of the data which relate beliefs and attitudes to actions have been acquired through interview or questionnaire. Respondents have been asked about their previous behavior during this same data collection period. Responses may reveal merely verbal rationalization for actions taken. Nevertheless, these data are used in this paper to make predictions about the potential acceptance of new preventives. The author would be on much sounder ground if experimental research could be carried out to determine whether varying these beliefs affects acceptance. A study currently being undertaken by the author is directed partially toward providing these data.

ACTIVITIES OF DENTAL PROFESSION WHICH MAY REDUCE PREVENTIVE DENTAL ACTIONS OF THE POPULATION

The dental profession in the United States has received societal sanction to set its own fees,

(Continued on page 17)

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5 ☐ Other _____	5 ☐ Prosthodontics	5 ☐ Chairside Assistant
YEARS IN PRACTICE	6 ☐ Dental Assistant	6 ☐ Other _____
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Journal of PREVENTIVE DENTISTRY

Abstracts of Articles in This Issue of the Journal of Preventive Dentistry
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Barnes, GP, Radentz, WH, Perkins, BE: Effects of Cetylpyridinium Chloride Containing Lozenges on Dental Plaque and Gingival Bleeding. 2 (July-August) 1975.

Abstract: The purpose of this examiner-blind clinical investigation was to evaluate the effects of commercially available throat lozenges containing cetylpyridinium chloride on bacterial plaque and gingival hemorrhage. Under the conditions of this experiment, the following findings were noted: (1) Use of the cetylpyridinium chloride lozenges did not significantly inhibit new plaque formation; (2) The lozenge use did not significantly reduce existing bacterial plaque accumulations; (3) Use of cetylpyridinium chloride lozenges had no significant effect on gingival sulcular bleeding; (4) The results of this study, involving cetylpyridinium chloride lozenge usage, are in contrast with the results obtained with mouthwashes containing the same agent.

Kegeles, SS: Public Acceptance of Dental Preventive Measures. J Prev Dent 2 (July-August) 1975.

Abstract: Without people's acceptance of new dental preventive measures, mass prevention will not occur. With the assumption that new preventives will be available through either home use or to visits to professionals, analysis is made of use of current dental preventives. Community water fluoridation, preventive dental visits, toothbrushing and diet are analyzed in regard to current status and factors which reduce greater useage. Predications are made of the likely acceptance of immunizating procedures, immunization with "boosters," short time use, constant everyday use, and use as dietary additives. Three strategies are analyzed: provision through individual dental practitioners, mass persuasion of adults and children, and provision through schools. Suggestions are made of means a dental practitioner might use

Manley, JL, Limongelli, WA, Williams, AC: The Chewing Stick; Its Uses and Relationship to Oral Health. 2 (July-August) 1975.

Abstract: The chewing stick or sponge is the principal implement of oral hygiene of the natives of Africa and other countries. It is obtained by isolation of the roots of the tree, *Terminalia Glaucescens* or from another tree, *Terminalia Togoensis.* The stick carries symbolic meaning for the Yoruba people in Western Nigeria in connotation of affection. This device has been used with great success by the peoples employing it in respect to oral hygiene. An illustrative case presents evidence of its success in a young Ghanian woman exhibiting excellent oral hygiene and periodontal status. An investigation of family history, dietary and cultural patterns is included. A thorough description of the technique employed by the patient is given. Conclusions suggest success with the device but point out difficulties in evaluation and suggest further investigation will result in contributions in the prevention of periodontal disease and enhancement of oral hygiene in the United States.

Abstracts (Continued)

for increasing acceptance. It is noted these means will account for acceptance by relatively few people. Note is made of mass media use and why health communicators have difficulty in mass efforts. Finally, analysis is made of use of new dental preventives in schools. Problems are noted for forced compliance, legal compliance and supervised compliance. Potentiality of success of school dental health education is offered.

(Continued from page 12)

train its own members and organize its own activities in the way it sees as most appropriate for providing services—primarily by providing restorative dental services to patients on a one-to-one basis using a fee-for-service payment scheme. It has also chosen to isolate its practitioners from each other in single offices and to isolate dentistry from other health services.

With these definitions of its activities, the profession tends to: recruit students who prepare for dentistry by studying biological and physical sciences and who visualize dentistry as a technical skill field[11]; emphasize training in restorative dentistry in its dental schools and to neglect training for patient education and prevention; provide relatively little teaching of patients in its offices[10]; restrict tasks which auxiliary personnel are allowed to carry out[24]; produce little interest in its members in functioning in public school settings[35]; and it tends to be concerned essentially with patients who can pay for the restorative dental services it provides. There are no sound data which show that these activities aversely affect preventive dental practices of the population.

However, many of these practices appear to have the potentiality for doing so. Because of the nature of the organization of the dental profession and the way it defines its goals and trains its new recruits, we would expect certain problems within the dental-patient relationship which might have impact on whether patients carry out preventive activities.

FACTORS IN DENTIST-PATIENT RELATIONSHIP WHICH MAY REDUCE PREVENTIVE DENTAL ACTIONS

An extremely limited amount of research has been carried out on the dentist-patient relationship. According to survey data summarized by Kegeles,[20] patients complain about: fear of being admonished by dentists for delay in coming for treatment; receiving criticisms for failing to reach "unreasonable" home care standards rather than praise for their efforts; and being provided little information within the dental office. In addition, little or no attention seems to be paid to "preparing" patients for dental surgery[2] or to assessing the possible psychological effects on patients of new dental equipment in the dental operatory.

These few studies which have focused on the dentist-patient relationship have not been directed toward determining its effect on preventive behavior of patients. Again, however, these problems seem to have the potential for reducing preventive actions.

POTENTIAL ACCEPTANCE OF NEW PREVENTIVE MEASURES

According to a series of recent publications[22,28,31] development within 5 areas of investigation offers promise of reducing caries and periodontal disease greatly: (1) serums which can be used for the immunization of the public against dental caries and periodontal disease; (2) dietary additives which can reduce the effects of bacteria on tooth enamel thus reducing caries; (3) high dosages of fluoride which can be used either locally or topically to protect enamel against the invasion of cariogenic agents; (4) antimicrobial agents, including antibiotics, anti-bacterial compounds and enzymatics which affect the microbial plaque and (5) plastic sealants painted on enamel to afford protection against cariogenic agents. Continuing research is being conducted within each of these 5 areas with differential levels of success. The current status of this research has been dealt with in detail elsewhere.[28] Thus, an analysis of the anticipated acceptance of these new developments by the public when they become available for mass distribution seems appropriate.

If serums for the purpose of immunization are developed for mass usage, they will have to be provided by inoculation or by oral dosage. They will be provided either in a single "dose," or a series of "doses" over a short period of time, or they will be provided through a series of "boosters" over a number of years.

Dietary additivies must be packaged with another food stuff (salt, sugar, cereal) which is consumed by a large proportion of the population or in separate tablet or liquid form which the public will be urged to use on a routine basis.

Fluorides are already available in a number of forms. They are available in tablets which can be purchased on a prescription basis, in gel form for use under supervised conditions in the dental office or within a school, in dentifrices and mouthrinses for use at home under unsupervised con-

ditions or in school under supervised conditions, and in "topical" form in which fluoride is applied to teeth by a trained person within a dental office or within a school.

Antimicrobial agents, if they are to be used systemically, will probably be provided in immunization form. If used topically, they will probably be provided as mouthrinses, dentifrices or gels.

Finally, sealants are being tested currently in professional offices and in schools through a "painting on" process. They will probably become available for mass use in these same forms.

SOME PREDICTIONS ABOUT THE ACCEPTANCE OF NEW PREVENTIVE MEASURES

Based on data presented till now, and on data from experiences of medical administrators who have attempted to develop procedures to prevent diseases, it seems possible to speculate about the potential acceptance of new preventives if they take one or another form and to analyze the potential yield of using certain strategies for increasing their acceptance.

First, no matter what preventive is developed for mass usage, it will probably be used less by persons with less education and lower incomes, blue-collar workers, Negroes, Puerto Ricans, Mexican-Americans, males, and those over 45.

This will occur whether the preventive agent is paid for by the individual or through a "third-party" scheme. However, there is likely to be appreciably less acceptance if the agent must be paid for by the individual. Acceptance of the agent is likely to be inversely related to its cost and to its accessibility.

In addition, the clinical effectiveness of the agent and the amount of inconvenience required for its usage, including time, frequency and amount of interference with "life style" of the population, will relate to its acceptance. In terms of ranking by possible liklihood of adoption, agents will most probably be accepted:

(1) If made available on a single dosage procedure. Even with such a procedure, a large proportion of the United States population failed to take advantage of the Salk polio vaccination. The Sabin oral vaccine was accepted more readily by the population. However, periodic oral dosages over a short period of time were not accepted as readily. Though the population sees itself as quite susceptible to dental disease, the fact that dental diseases are considered so much less serious than polio leads to the prediction of less acceptance for a dental inoculation. Perhaps the best means for achieving acceptance of a dental inoculation is to include it with the routine diphtheria, pertussis, tetanus, polio inoculation.

(2) If provided through an immunization procedure which is repeated a number of times over a period of years. An analogy is the "booster" shot for tetanus. As with tetanus, one might predict a gradual lessening of perceived vulnerability to dental disease over time. Since dental care is obtained now largely because peoples' perception of their own vulnerability is constantly reinforced by new outbreaks of caries or periodontal disease, decreasing vulnerability without increasing perception of seriousness is likely to lead to decreased acceptance over time.

(3) If provided through a procedure which requires the person to carry out an activity which interfers with his "life style" briefly, but which confers lifelong immunity. A procedure of this kind may instantaneously reduce perception of susceptibility. However, even brief change in "life style" reduces the likelihood of acceptance. Whether this procedure, or the procedure of immunization with "booster" will gain greater public acceptance needs empirical testing. We might expect differential acceptance of the two procedures within the population even if overall acceptance by the population were the same.

Agents are more likely to be rejected:

(1) If provision is made through a procedure which will require the person to carry out activities which interfere with his "life style" on a number of occasions. Should the procedure reduce perception of susceptibility, it may not be repeated more than a single time. If he, or others with whom he identifies, are reafflicted by the disease after taking a single action, he may believe that the procedure is ineffective rather than accepting the need for its periodic use.

(2) If provided through a technique which must be carried out each day forever and which interferes with "life style" each time it is used. This is exemplified by current procedures for

controlling plaque. A new procedure which is more effective than those which now exist but which requires the same amount of interference with "life style" is likely to be adopted by a sufficiently large group to ensure increased income for the company which owns its patent but not large enough to greatly increase mass prevention (*e.g.*, fluoride toothpastes are probably used by 35–40% of the population, most of whom shifted from use of another toothpaste).

(3) If provided through a procedure which requires the person to visit his dentist at regular and periodic intervals for the remainder of his life. This method also requires the profession to adopt the procedure.

(4) If provided through a mechanism which requires the population to change or augment its diet. A method analagous to that which legally requires manufacturers to add a substance to their product (iodine to salt, vitamins to breads) may be successful. However, legal requirements of this kind may be quite difficult for dentistry to obtain as a result of the history of conflict about community water fluoridation.

Measures with high clinical effectiveness are likely to be accepted more readily than measures with low clinical effectiveness, no matter how they are provided. Measures which require a large change in "life style" are likely to be accepted less readily than those which require less change no matter how they are provided. The degree of clinical effectiveness of a dental measure would have to be much higher and the degree of interference it requires much lower than would be true for a measure which has been developed to prevent heart disease or cancer since the latter two diseases are seen as so much more serious by the public.

MEANS FOR INCREASING PUBLIC ACCEPTANCE OF NEW PREVENTIVES

Efforts to increase public acceptance of preventive measures might be more successfully directed toward changing the dental profession and its practitioners. Suggestions of needed changes in recruiting and training students, dental school curriculum, payment systems of dentistry, uses of auxiliary personnel, means by which the profession is organized, processes of licensure and reciprocity and in distribution of manpower have been discussed in recent papers.[1,8,20,24,27,32] However, a strategy of this kind is directed only toward that part of the population which seeks dental care on a routine basis, or toward less than 50 per cent of the United States population. Material with that emphasis will be presented shortly.

Alternatively, it is possible to place emphasis on means for increasing acceptance of preventive measures by the total population. For adults, an emphasis of this kind requires mass persuasion efforts through the use of mass media, for children, through the school systems. In addition, it is possible to emphasize methods which force children in schools to comply.

1. *Means For Achieving Acceptance Of New Preventives In The Dental Office*

As Young[38] notes, "in a recent review of the literature on primary and secondary prevention in the dental health field, not a single study was found related to the effectiveness of time spent by the dentist in educating patients in good oral hygiene practices." Thus, only guesses are available concerning means which are effective in increasing patients' acceptance of preventive activities. Efforts by Suomi* and Arnim* have been relatively successful in controlling plaque among patients who remained in programs. These procedures provide information about dental effects among patients who accept procedures instead of information about factors which lead to acceptance of procedures. Even though many clinicians have undoubtedly been successful in getting their patients to accept preventive activities, they have not systematically revealed the means used for achieving success.

Thus, we are forced to turn to theoretical notions for achieving acceptance by the dental practitioner instead. An excellent paper by Weisenberg[36] suggests a number of new techniques which might be used for achieving acceptance:

1. For retaining patients in treatment
   a. Preparing patients for what is to occur
   b. Providing procedures to relax patients, including hypnosis

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* Papers presented at a conference on Motivation and Communication in Preventive Dentistry June 11, 12, 1970, Columbia University, New York.

c. Using techniques of "modeling" by having patients observe other persons undergoing similar treatment
d. Desensitization or reciprocal inhibition techniques
e. "Forcing" patients to admit that procedures are not really difficult

2. For following instructions while under treatment
   a. Designing an explicit "contract" which both patient and practitioner agree to observe
   b. Explicitly defining behaviors to be carried out and means for doing so
   c. Keeping records shared by patient and dentist
   d. Reinforcing the patient positively each time he follows instructions in order to "shape" his behavior
3. For maintaining appropriate activities after termination of treatment
   a. Organizing self-reinforcement techniques including that of record keeping
   b. Allowing patients to develop their own standards of activity prior to leaving treatment
   c. Providing dental care to families or to peer groups simultaneously, so that each member can reinforce other members.

Research has just barely begun using these new techniques in dentistry. If they are to be used successfully, research support must be provided to determine their usefulness.

Obviously, however, achieving acceptance of preventive measures within the dental office will be useful only for the proportion of the population that visits dental offices. Moreover, even among that restricted population base, only those who visit dentists regularly will be amenable to accepting new preventives. Unless the profession is reorganized drastically through third-party payment systems or through governmental intervention, this will hardly account for a large proportion of the population. Thus, we need to look at procedures for use outside the private dental office to achieve mass acceptance of new preventives.

2. Considerations For The Use Of A Mass Communication Approach For Achieving Acceptance Of New Preventives

Research in the area of mass communications has been impressive in its volume. An extremely perceptive summary of the effects of mass communication listed about 600 references.[37] Yet the author of that summary states the 600 references include only a small segment of research done. Thus, statements which follow are quite superficial.

In order to achieve public acceptance or change through the use of mass communications, the following considerations must be taken into account: (1) Mass information campaigns have been found successful in providing information and in eliciting actions already motivated but not in changing motivation. Thus, effects to persuade people to use one toothpaste rather than another, or one mouthrinse rather than another may be successful for persons who use toothpastes and mouthrinses. It is not as likely to be effective in persuading persons who do not now use toothpastes or mouthrinses to do so. Moreover, persons who use toothpastes and mouthrinses for cosmetic purposes are not likely to be persuaded to use new preventives by mass communication programs which stress health benefits. (2) In order for mass information programs to be successful, people must: a) Be exposed to the communication; thus print media, read rarely by the poor, is not a useful vehicle to achieve acceptance of new dental preventive measures by the poor, while broadcast media, to which the poor listen greatly, may be a more appropriate vehicle for this purpose; b) Understand the communication; thus, the message must be transmitted at an appropriate level for the audience; c) Retain the communication; d) Identify with people pictured in the communication; many anti-cigarette commercials portrayed people with private swimming pools, large houses and business suits, which is hardly a population similar to many in the intended audience; e) Be provided specific actions to take; the typical health communication which suggests, "see your doctor" is much too vague; f) Be told to take actions which fit their life style and which are possible for them to follow; g) Be told what to do by persons whom they consider credible, that is

(Continued on page 22)

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[1] *Accepted Dental Therapeutics 1973/74*, 241-242
[2] Aasenden, R., and Peebles, T. C.: Effects of Fluoride Supplementation from Birth on Human Deciduous and Permanent Teeth. *Archs. Oral Biol.* 19:321-326, 1974
[3] Mellberg, J. R., Nicholson, C. R., and Law, F. E.: Fluoride Concentrations in Deciduous Tooth Enamel of Children Chewing Sodium Fluoride Tablets. *Journal of Dental Research* 51 551-554, 1972

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(Continued from page 20)
persons whom they define as trustworthy and persons whom they define as expert.

It is perhaps more useful to use a number of small mass information efforts which are directed at particular sub-groups in the population rather than to use a single large effort which attempts to persuade everyone simultaneously. Current thinking about the effects of mass communications is that they are best used when consumers wish information which is then supplied to them by mass communicators. When the consumer wishes information, he seeks it out. It is at this time that information should be available. For instance, if a cancer cure or preventive is found, most people will immediately seek information on how the preventive can be obtained. If a totally effective dental preventive is found, many people will seek information on how the preventive can be obtained. It was suggested much earlier that the use of such a preventive will depend on the complexity and difficulty of its use. Information provided through the media will be invaluable in those respects. A very interesting critique of the use of mass media in increasing preventive dental practices has been made by Swinehart.[33] It resembles the formulation indicated here in many ways.

In effect, a very modest role is suggested for the use of mass media in achieving the acceptance of new dental preventives. It is usually at this time, the author has found in spoken addresses, that his audience asks, (1) why can't health people use the same procedures to help "sell" new preventives as the commercial advertiser? and (2) why can't health people achieve the same great success as advertisers do?

3. *Use Of Commercial Advertising Methods By Health Communicators*

A number of social scientists[3,13,19] have analyzed uses of mass media by advertisers and health persons and suggested answers to these questions. An attempt to replicate these answers here would take us very far away from the objectives of this paper. Perhaps it is sufficient to say (1) the goal of the advertiser, that of maximizing profits, and of the health communicator, that of preventing and controlling disease are quite different; this difference in goals has a number of important ramifications in how mass communications are used, (2) the ethical traditions of the two groups are quite different; this leads to different public expectations of the amount of truth in the information each provides, and (3) advertisers have not been more successful than health communicators in using mass communications; in fact, a larger percentage of people in the United States carry out most health recommendations than use any particular brand of product.

Because of limitations in space, the effects of these differences cannot be spelled out here. However, the author suggests again that the major role of mass media in achieving acceptance of new dental preventives will be that of providing information which the public is interested in acquiring.

It was suggested earlier that strategies other than that of the use of mass media are also available for achieving acceptance of new dental preventives. It was noted that opportunities might be available to achieve acceptance within situations where the population spends the greater part of its day. We will not deal with such methods for adults other than to note that adults are required frequently to have physical examinations or immunizations for employment, travel or insurance purposes. Instead, we will turn to methods of obtaining acceptance of new preventives among children in school settings since children are together in schools a large part of each day.

4. *Means For Achieving Acceptance Of Preventives In School Situations*

Kelman[21] suggests three methods of achieving opinion change: compliance, identification and internalization. These same methods can be analyzed for their use in achieving changes in behavior whether or not behavior change is coupled with changes in opinion, beliefs or attitudes.

METHODS OF FORCED COMPLIANCE

By compliance, we mean both a process through which the child and his parents are led to believe that the child is required to take certain actions, whether or not the requirement has legal status, and a process in which the child is supervised closely to insure that he takes

certain actions. A system of forced compliance is the most effective means for obtaining child acceptance. It has been used for achieving acceptance of communicable disease assessment and immunization.

Legal Compliance

In some communities, children are required to have the diptheria-pertussis-tetanus series of inoculations before they can start school. In other communities, parents are led to believe these inoculations are required even when there is no legal sanction for failing to do so. In still other communities, parents are led to believe physical examinations are required for children when they enter the school system from other communities or when they move from elementary to junior high school and from junior high to senior high school.

Immunization against polio has been added to the earlier list of required immunizations in many United States communities. Suggestions have been made to add measles vaccination and venereal disease detection to the list of required health activities for children. Thus, a suggestion that children be required to take a preventive for dental disease fits into an accepted tradition.

It may be appropriate to question the ethics and morality of this tradition in a democratic society. The tradition is justified by the principle that society must protect itself in any manner necessary against communicable diseases.

If current research is successful in developing new dental preventives which can be used easily for school children, and if a community dentist decides a legal strategy for obtaining compliance is appropriate, he will be faced with a number of difficulties. Among them are the following:

1. School authorities, like many members of the population, are not likely to see dental disease as sufficiently serious for mandatory immunization.
2. Evidence about the communicability of dental disease is not very convincing at this time.
3. School authorities, in a number of communities, have started to question the legitimacy of using schools for non-educational purposes.
4. The controversy about community water fluoridation, especially that which regards the "freedom of choice" of medication, is still fresh in the minds of many persons.

Supervised Compliance

The second means for obtaining compliance is that of close supervision of students. It has been used for obtaining compliance in field trials of mouthrinses, gels and dentifrices. In such studies, a sample of children, classes or schools are induced to carry out an activity under immediate supervision of field staffs. As is apparent by the literature, sites have been found for field investigations of this kind.

Schools have been willing to give permission for these studies since they are carried out with the stipulation that only children who volunteer and for whom informed parental consent has been acquired are used as subjects.

As an aside, this stipulation, which probably does not interfere with tests of the efficacy of dental agents, may greatly limit the acquisition of information useful for assessing acceptance of new preventives. Children who fail to volunteer or who fail to gain parental permission for participating in field investigations may also be unlikely to accept new preventives when they become available. Research is needed on characteristics of non-volunteers and of parents who fail to give permission for their children to participate. In addition, research is needed on means for persuading children and parents to participate in field studies in order to learn how to achieve acceptance of new agents. A study which is directed toward obtaining data on both of these matters has just been started by the author and his colleagues.

If the field trial model, that of close and constant supervision of school children, offers possibilities as a system for achieving acceptance of new dental preventives, it also presents a number of potential problems in its widespread use:

1. School authorities may be as unlikely to accept "supervisors" in the school on a regular basis as to accept an immunization procedure since both procedures are likely to be seen as diluting the education function of the school.

2. Such a procedure may be far too expensive for communities to absorb in order to provide dental disease protection or prevention.
3. Procedures of constant supervision may produce great pressures on children for conformity which can be defined as eliminating "freedom of choice" of medication and stimulate controversy within the community.
4. Dental practitioners in communities may not be willing to accept "dental treatment" in schools on a regular basis.

Research is needed to determine whether or not these are real problems, and if they are, the means by which they may be circumvented.

USE OF PERSUASION IN SCHOOLS TO ACHIEVE ACCEPTANCE OF NEW DENTAL PREVENTIVES

Activities directed toward persuading children to accept new dental preventives are akin to a regular school function described under the title, school health education. Excellent critiques of research in school dental health education have been written recently by Rayner and Cohen[29] and by Haefner.[14]

A number of interesting suggestions about the use of persuasive efforts within the school emerge from both reviews which are quite similar to those suggested earlier in this paper. For instance, Rayner and Cohen note that young students carry out new activities for a period of time as a result of persuasion, but regress to their normal level of behavior if the new activity must be carried out forever; that changes in behavior are accomplished better when advocated by "experts" (hygienists, dentists) than when advocated by teachers; that behavior advocated must be measured as changes in behavior rather than as changes in knowledge or attitudes.[29]

From the studies carried out, the school may offer a promising site to achieve mass acceptance of new preventives through methods of persuasion. However, we expect that new agents must be developed which are simple in administration, usable at home, and capable of providing immunity for long periods of time after only short periods of use if they are to be accepted by a large proportion of the school-age population.

Research is needed to determine whether or not this expectation is correct. It is needed now, or at least before new dental measures are developed for mass use. If data are not available on acceptance of the new preventive measures before they are developed, these measures may not be accepted any more readily than the preventive measures which are available currently.

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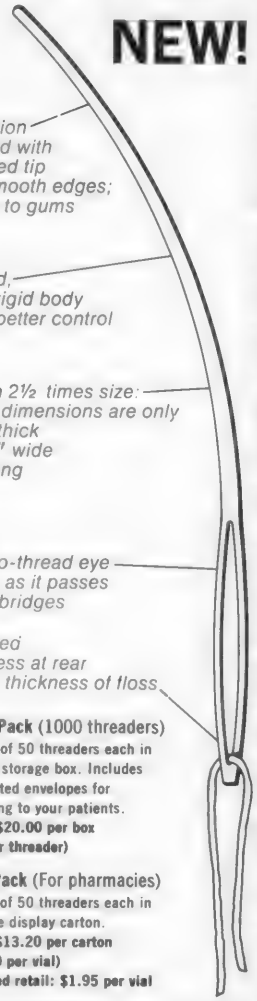
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Book Review

Practical Endodontics. BY S. LUKS, D.D.S. Philadelphia, Pa. J. B. Lippincott Co., 1974. Pages: 175. Price: $20.00.

The inside jacket overview states that the book is a compact volume that covers endodontic techniques step-by-step always within the framework of sound basic principles. Interwoven throughout the entire text is a philosophical concept that would do the profession credit if adopted *e.g.* "Patients are entitled to receive a dependable service and not a compromise based solely on the operator's capabilities."

There are no references and the text definitely reflects the author's personal endodontic approaches and individual preferences based on his extensive clinical practice. It is not intended to be a text that offers "variations on a theme."

The index is adequate and the continuity of subject matter is fluid. The ample illustrations are pertinent, however many are of uneven quality.

Although not without value, it has not added any new dimensions or innovative material to the existing endodontic literature. It will find a limited audience among endodontic specialists and can be used for supplemental reading by interested general practitioners.

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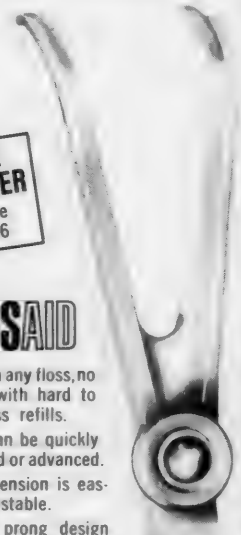

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sulcular hemorrhage. These results differ from those obtained with commercial mouthwashes containing cetylpyridinium chloride.

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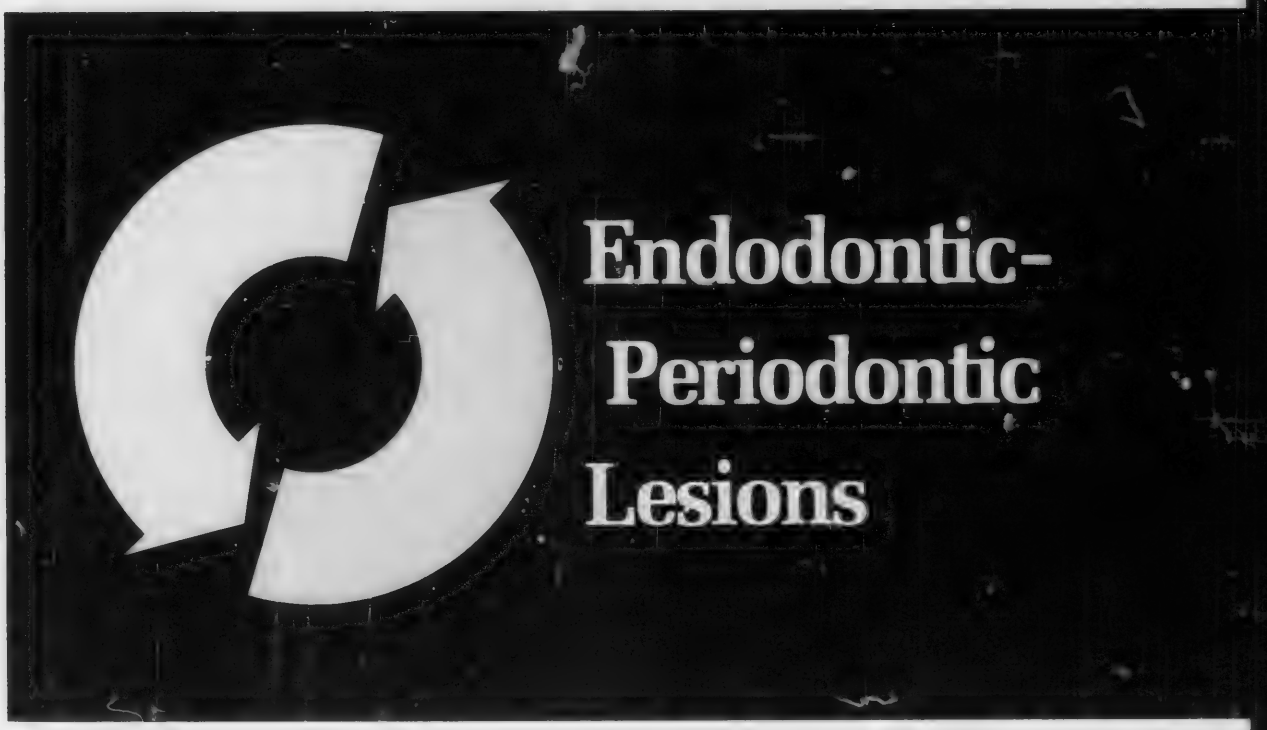

☐ The Interrelationship of Endodontic-periodontic lesions ☐ Preventive Endodontics ☐ Dentistry and the Federal Government ☐ Comparison of Two National Preventive Dentistry Surveys: 1957 and 1974

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preventive dentistry

Vol. 2 • No. 6 November - December 1975

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The Inter-relationship of Endodontic-periodontic Lesions

Lanny V. Kampfe, D.D.S., M.S.* and Frank A. Wingrove, D.D.S., M.S.**

In dealing with periodontic-endodontic relationships, one might first consider why special attention should be devoted to this subject. In general, these two areas are considered and taught as separate subjects although one biological unit with similar embryological development.[1]

Technologically, the specific therapeutic methods employed have been quite distinct, complicated by different biological factors which frequently cause diagnosis to be confusing. In spite of this confusion, which tends to separate periodontic and endodontic treatment, the inter-relationship of these two entities should be stressed. Biologically and clinically, the pathological processes are continuous between the pulp tissue and the periodontal ligament. The criterion then for a successful case is to treat either the periodontic or the endodontic lesion with the sequence of treatment dependent on the origins of the lesion. In dealing with this specific problem, we must consider first the specific diagnostic signs.

ENDODONTIC-PERIODONTIC SYNDROME

It becomes apparent that a periodontal pocket can originate from either of two etiological factors: pulpitis or periodontitis. The endodontic-periodontic syndrome involves inflammation or degeneration of the pulp with a clinical pocket of the same tooth.[2] The presence of this syndrome creates a problem in determining whether the lesion is of pulpal or periodontal origin. The following discussion presents clinical signs, symptoms, tests and radiographic findings used to determine whether periodontic or endodontic treatment should be instituted first.

Clinical Signs

Generally, the problem of severe pain is not encountered in periodontal disorders with the exceptions of a parietal abscess, food impaction, clenching, and necrotizing ulcerative gingivitis. Pain associated with periodontal defects is usually low grade and diffuse. Percussion indicates that the periodontal ligament is inflamed which may be due to periodontic, endodontic and/or occlusal involvement. Also the chronic endodontic lesion may be asymptomatic, but spontaneous pain or a history of prior episodes with pain usually indicates endodontic involvement. Acute pain is spontaneous, throbbing and localized to the area of the inflamed tooth.

Cellulitis affecting facial planes of the mandible or maxilla is seldom observed in periodontal disease. Most often periodontic swelling involves the alveolar mucosa, whereas swelling associated with endodontic lesions most frequently involves the mucobuccal fold area.

For the patient who complains only of pain to percussion but has a vitally responsive tooth and a periodontal lesion, periodontal treatment should be started with comparative pulp testing continued during and after periodontal treatment.

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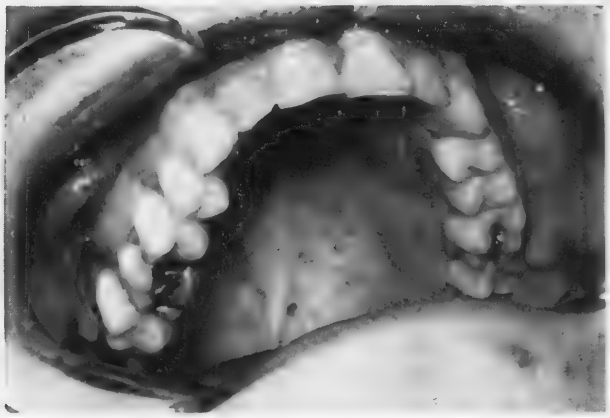

Fig. 1. A patient with advanced periodontal disease. Note the gingival contours in the posterior embrasures.

Fig. 2. Periapical working length roentgenogram of the maxillary molars of the patient in Figure 1. Observe the retrogenic infection of the pulp from the deep periodontal pockets.

Remember that a multi-rooted tooth with a periodontal pocket extending to the apex on one root, which has necrotic tissue in that root, may test within a normal range due to vital pulp tissue in the remaining roots. If such a tooth was left untreated, the pulp tissue would continue to degenerate. A calcified canal could result, making future endodontic treatment more difficult and degradation products would retard healing of the periodontal lesion. In cases of combined endodontic-periodontic involvement, with or without complaints of pain, endodontic treatment should be done first (Fig. 1 and 2).

Varying with the resistance of the patient, the toxic pulpal degradation products will gradually be localized to form a granuloma or an abscess. In the case of an abscess, the accumulated pus will then follow the path of least resistance, forming a sinus tract.[3] To help identify its origin, a diagnostic gutta percha cone can be placed in the tract (Fig. 3). Endodontic lesions most frequently originate at the apex, with the sinus tract penetrating the alveolar mucosa, not necessarily opposite the involved tooth.

In some cases, the path of least resistance will be along the periodontal ligament. What originally was an endodontic problem now necessitates periodontal management. In such cases where only an isolated tooth in an arch is involved, perform endodontic treatment first, postponing periodontal treatment until a new state of bone fill can be determined. Cases which can be treated during the early stages of their development, having a three-walled bony pocket, will have a better prognosis than the chronic case where a sinus tract has denuded the root surface of cementum with only two walls of bone remaining.

The amount of remaining bone cannot be determined from the radiograph because a three-dimensional process is superimposed on a two-dimensional x-ray film. The radiograph is only a diagnostic aid, with periodontal probing essential to measure remaining bone. In Figure 4, note the radiolucent line paralleling the file in the pulp canal. Only by probing around the tooth was it found that there was an anomalous lingual groove extending from the cingulum to the apex of the tooth (Fig. 5). Such a

Fig. 3. A diagnostic gutta percha cone traversing a palatal sinus tract to the apex of the molar.

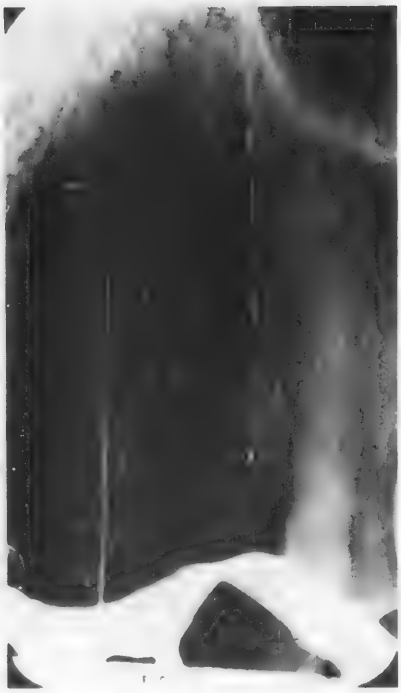

Fig. 4. Periapical working length roentgenogram of an abscessed lateral incisor. Observe the radiolucent line paralleling the file.

Fig. 5. The radiolucent line observed in Figure 4 was this anomolous lingual groove extending from the singulum to the apex.

groove results in an untreatable periodontic condition and this tooth should be extracted.

EFFECTS OF THE PERIODONTAL LESION ON THE PULP

As early as 1927, degenerative changes in the pulp of periodontally involved teeth were noted.[4] Today, histological examination of the roots and furcation area of teeth reveal numerous accessory canals communicating between the periodontal ligament and the pulp tissue.[5] These canals contain capillaries and loose connective tissue providing a pathway for bacteria and toxins to travel through dentin from the inflamed periodontal ligament. Their presence makes it easy to understand how periodontal lesions involving them actually expose the pulp. The exposure interferes with the nutritional supply to the pulp and small regions of necrosis and calcification are observed at the termination of these accessory canals within the pulp. The ability of the pulp to recover from these injuries depends on the nutrition, size and number of exposed accessory canals, and the presence of additional irritants.

Drugs used for desensitization of the exposed root are some of these additional irritants. If these chemicals enter the pulp, they may initiate necrosis. A better procedure would be to gently polish and burnish the exposed root surface. The mild irritation will act as a stimulus to odontoblasts to produce peritubular dentin which will decrease tooth sensitivity. If prolonged, severe sensitivity from persistent pulpitis following periodontal treatment is the chief complaint of the patient, then endodontic therapy should be performed. The vital pulp is only needed for root formation and should not be considered sacred at the expense of patient comfort.

Slowly advancing periodontal disease also acts as a mild irritant stimulating the production of secondary dentin. Pulps of periodontally involved teeth have smaller than normal cells with increased collagen and calcific deposition. However, during vigorous scaling and curettage the cementum is removed and the accessory canals can be exposed.[5] Severe periodontal pockets can extend to the apex of the involved tooth, as well as resulting in apical granulomous and external resorption of the root. Internal resorption has also been demonstrated adjacent to the openings of accessory canals. The pulp of the

Fig. 6. A perforated and over filled maxillary molar resulting in a chronic periodontal irritation.

Fig. 7. A periodontal lesion and caries involving the distal root of a mandibular molar.

periodontally involved tooth may also undergo pressure atrophy due to increased mobility resulting from increased hydraulic pressure from extracellular fluids within the socket and pulp system. In the face of severe inflammation the pulp does not have the collateral circulation which is available to other tissues and pulpal death will ensue.

THE EFFECT OF ENDODONTIC LESIONS ON THE PERIODONTAL LESION

The persistence of an inflamed or necrotic pulp will retard healing of the periodontal defect even after periodontal surgery. As previously stated, passage of the toxins of pulpal degeneration through the pulp canal system can create periodontal lesions and resorption of crestal bone.[5] It must also be remembered that medications used during endodontic treatment are toxic to human cells as well as to bacteria. These medications should be used sparingly or they may be expressed through the pulp canal system into the apical, radicular or furcation area causing irritation of the periodontal ligament. No medication is as beneficial to the healing of the supporting tissues as is complete debridement of the pulp tissue. Also the partial extirpation of the vital pulp tissue and over-instrumentation will result in inflammation of the periodontal ligament and cause tenderness to percussion.

Another cause of a periodontal defect is the tooth that is perforated during endodontic treatment (Fig. 6). The prognosis for retention of such teeth depends on the location, duration, and size of the perforation and how soon and how well it can be sealed. A poor seal in any portion of the pulp canal system, due to a perforation or where there may be accessory canals connecting with the periodontal ligament, will lead to a chronic lesion.

Following proper endodontic treatment the most dramatic healing and bone-fill occurs in the endodontic-periodontic cases where the periodontal pockets were created by pulpal disease. In cases where the pulp has become secondarily involved, combined treatment is necessary with periodontal surgery immediately following endo-

dontic treatment. The amount of bone-fill must always be evaluated after endodontic treatment. To eliminate acute symptoms by removing only the inflamed pulp and then to leave the tooth with a chronic periodontal lesion, which may be tolerated with only dull pain to pressure, is an injustice to the patient. Through combined periodontal-endodontic therapy, the goal of maintaining a healthy functional tooth can be reached.

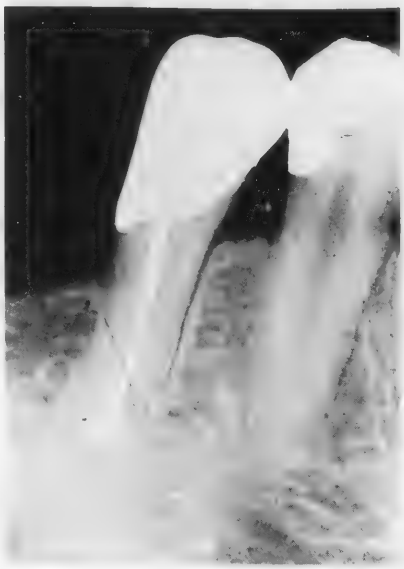

Fig. 8. The same molar in Figure 7 following combined endodontic-periodontic treatment.

DISCUSSION

The treatment of choice is the simplest procedure that will obtain the most ideal therapeutic result. Often the clinical picture is that of a funnel shaped pocket extending from the gingival margin apically, with communication between the marginal and the apical lesion. The classical signs of gingival inflammation are present and mobility is present due to loss of attachment. Depending upon the extent of destruction, extraction may be indicated. In most cases combined endodontic-periodontic therapy will be successful. The actual therapy planned depends upon form and extent of bony destruction, location of the tooth in the dental arch, and the vitality of the pulp. Once the lack of vitality or degeneration of the pulp is determined, root canal therapy is initiated.[6] If the tooth is vital and the bony configuration meets the requirements for infrabony techniques, reattachment is the objective choice. If the tooth is non-vital, or bony topography precludes the reattachment attempt, amputation of the affected root with combined root canal therapy may be indicated (Fig. 7). By use of these combined techniques, the remaining tooth or portion of the tooth may be utilized as a unit, or may serve as an abutment for fixed prosthesis (Fig. 8).

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Preventive Endodontics

Herbert F. Spasser*

Preventive endodontics is an integral part of preventive dentistry. It is the integration of many facets pertaining to our consideration and treatment of the patient and his teeth. Preventive dentistry has been defined as a philosophy with an ordered set of priorities. As dentists, our primary concern is to prevent the initiation and onset of dental disease, secondly to prevent the progression and recurrence of dental disease, and third to prevent the loss of masticatory function.[5]

Any discussion of preventive endodontics must, of necessity, range from pulp protection, to pulp involvement without its removal, and to prevention of the sequellae of undiagnosed or improperly treated involved teeth.

1. *Total Prevention*

Much has been written extolling the merits of total prevention and crown protection. This, naturally, is our primary objective since at this stage the teeth are in the ideal situation. Briefly, some of the following[1] aid in our quest to attain this end: (1) Fluoridation of community water supply; (2) Topical application of fluoride to teeth; (3) Restriction of cariogenic foods; (4) Home oral hygiene; (5) Periodic examination and prophylaxis; (6) Incipient caries detection and restoration; (7) Mouth guards (where applicable) to prevent traumatic injuries.

2. *Pulp Protection*

Since the dental pulp is that part of the tooth which most frequently reacts to the varying stimuli attacking it, we must successfully protect this organ from the excessive trauma which can cause an adverse response, infection or death. The pulp will elicit a response directly commensurate with the intensity of the physiologic assault.[11]

Any living or non-living pulpal irritants will first manifest themselves through the effectation of the odontoblasts.

Pulpal inflammation may develop following the application of these irritants to teeth. This may resolve if the irritant is mild or removed. The response may proliferate if the irritant continues for a prolonged period. Eventually there may be either repair or necrosis.

We know that caries, microorganisms, chemicals, and operative procedures all take their toll of pulpal resistance. Our aim is to reverse this response.

A. Caries. The response of the pulp to caries within dentin is highly variable. Development of caries may be so rapid that dentinogenesis is relatively unstimulated or lysis of dentin ground substance so physiologically gentle that secondary dentin fails to form. As a general rule, however, most carious processes will induce a secondary response on the part of the odontoblasts, but it is difficult to predict the rate of this response.[11] This secondary dentin defense reduces the pulp volume and the aging process is accelerated. This, in effect, diminishes the ability of the pulp to defend itself against further irritants. When the caries progresses more rapidly than the elaboration of reparative dentin then chronic inflammation becomes evident in the pulp. Thus caries removal at its earliest detection has been a cornerstone in preventing increased pulpal disease.

B. *The prevention of periodontal disease* is intimately involved with preventive endodontics. Cemental exposures and erosion of the cementum denude root dentin and elicit a pulpal response similar to the action of caries. Thus, teeth with broadly exposed roots frequently present constricted pulps and decreased pulp space.[11] Increased pocket depth, in extreme periodontal involvement, can cause pulpal infection by allowing invasion of microorganisms through lateral canals, especially in the

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furca of molars. Terminal periodontitis will result in eventual retrograde apical involvement and inflammation. Because the pulp remains vital in these cases due to its ability to maintain its vascularity, acute pulpal pain is the result.[8] The elimination of occlusal prematurities must be included to prevent pulpal trauma.

C. It is in the area of *operative procedures* that we reach the broadest based concern, for our control of results at this time is greatest. Seltzer and Bender[8] feel that some commonly used operative procedures endanger the health of the tooth more than the disease process that they are intended to correct. Decay, in many instances, they feel, is much less harmful than the operative procedure used to treat it. If the dentist can modify his techniques to cause minimal damage to the pulp, he will reduce the eventuality of endodontic treatment or extraction. Adherence to the following principles can help further that goal:

(1) The most significant agent producing a response to the underlying odontoblasts is the amount of heat produced in the tooth during operative procedures.[11] Therefore, use of a well-directed water spray coolant is our first cardinal rule.

(2) The greatest amount of odontoblastic damage occurs at speeds up to 50,000 rpm and the least occurs at speeds from 150,000 to 250,000 rpm, provided the coolant is used properly.[8]

(3) It has been shown that less severe reactions occur when smaller rotary instruments are used in the preparation of teeth.[9]

(4) The more deeply a cavity is prepared in relation to the residual thickness of dentin overlying the pulp, the more severe will be the intrapulpal response.[11]

(5) The total number of dentinal tubules cut bears a strong relationship to the total response of the pulp. An overwhelming response can occur when all the coronal tubules are cut, as in a full crown preparation.[11] It is obvious the more conservative the preparation and restoration, the less damage to the pulp.

(6) Knowledge of morphology to prevent pulp exposure must be given constant consideration during any operative procedure.[2]

(7) The use of air spray or an air coolant alone during cavity preparation presents a potential hazard to the pulp and should be avoided. Cotton pellets should be used to dry teeth rather than air since Langeland[3] has shown that a 10-second blast of air on dentin is enough to produce displacement of odontoblastic nuclei.

(8) It has been shown that the heat and pressure of copper band compound impressions cause bacterial invasion of the dentinal tubules and inflammation of the odontoblasts and pulp. It would therefore be advantageous to use hydrocolloid or rubber impression materials.[8]

(9) Cavity liners should be used under all deep restorations, especially silicates.

(10) Zinc oxide and eugenol sedation should be employed to allow a hyperemic pulp to recover prior to placement of the final restoration.

(11) Irritating materials should not be used as temporary fillings. It has been shown that gutta percha, because of its leakage and cavit because of its dehydrating affect can cause adverse reactions of the pulp.[3]

(12) During the preparation of teeth for a fixed prosthesis, it is advisable to make use of telescoping copings to achieve parallelism rather than to overprepare the teeth with possible injury to the pulp.

(13) Chemicals such as phenol and silver nitrate should not be used on cut dentin as these have been shown to be harmful to odontoblasts. Sterilization of dentin is not necessary since evidence shows that the deepest layer of dentin is not infected.[8]

(14) From an evaluation of all the filling materials, it can be concluded that there is no filling material which meets all of the physical esthetic and the biological criteria. As a result we must rely upon the judgment of the operator to select the proper material to meet the need of the situation and to handle the material correctly.[8]

3. *Pulp Involvement with Total or Partial Preservation*

There are several occasions when the degree of pulpal involvement is so moderate that it is possible to avoid complete pulpectomy, if only for the moment. Varying degrees of success of the following procedures have been reported in the literature.[5–7,9]

A. *Indirect pulp capping* is indicated in predetermined cases to promote healing of the dentin and pulp. The remnants of leathery decay are not removed from dentin overlying the

pulp. Complete excavation at this point will result in pulpal exposure. Both calcium hydroxide and zinc oxide eugenol cements have been used as vehicles to stimulate secondary dentin formation.[6] There are those[7] who prefer to place a permanent restoration at the same time the procedure is done while others[6] prefer to reexcavate and completely remove the remaining caries after dentinogenesis has completed its defensive work.

B. *Pulp capping* is indicated mainly for mechanical exposures in young teeth, in which the vascular supply is greatest, especially those with incompletely formed root ends. With advancing age, the chances for successful pulp capping diminish because of normal aging of the pulp. This procedure may also be employed in the vital deciduous tooth which will only be retained for a short time.[8] Recent studies have shown greater success histologically using Dycal as the medium rather than calcium hydroxide and water.[10]

C. When the pulps of young teeth have been exposed by dental caries, *pulpotomy* is indicated. This is an intermediate treatment until such time as apical root formation is complete. Subsequently, pulpectomy is instituted with greater assurrance of proper seal and success. Pulpotomy is also highly successful in deciduous teeth and is preferable to complete endodontic procedures in deciduous teeth with chronic pulpitis. If complete necrosis has occurred, pulpotomy, however is valueless.[8]

4. *Prevention Through Diagnosis*

Our discussion of preventive endodontics could not be complete without including the final category of differential diagnosis. It is here that caution, patience and skill can conserve root structure and prevent many of the problems arising due to misdiagnosis.

Often we are called upon to treat a patient whose symptoms of pain or radiographic findings mimic endodontic problems. These cases, after careful consideration, need no endodontic therapy at all, *e.g.*:

(1) Sinus infections causing severe pain in maxillary teeth can cause much grief to both patient and dentist. Endodontic treatment will not cure this problem and the patient must be referred to the proper physician.

(2) Recognition of the cracked tooth syndrome has become quite common in recent years. The patients' complaint is sensitivity to cold and usually tenderness to biting. Frequently the pulp is not involved at all and binding the cusps with an onlay or crown will alleviate the symptoms.

(3) There are many radiolucencies that are not the result of pulpal pathology. Almost all of these teeth will test vital and will not require treatment. Bhaskar[1] has listed many of these, including various types of cysts (traumatic, periodontal, palative etc.), neoplasms, and osteofibrosis.

(4) Large periapical areas of rarefaction must be suspect, and all the apparently affected teeth should be tested for vitality. This type of radiolucency, superimposed over the apices of several teeth, will heal when the sole offending tooth is endodontically treated.

Consistent with our thinking in prevention, and our goal of maintaining minimum patient problems and discomfort, is the area of interceptive endodontics. Here, with careful diagnosis, we can avoid unwanted sequellae caused by supervised neglect.

(1) Internal resorption will first appear on the radiograph as a circular enlargement of some portion of the pulp chamber or canal. We know that if left unattended the cellular elements causing this pathology will eventually lead to root perforation. Therefore, endodontic therapy should be instituted as soon as this situation is discovered.

(2) Calcification results in the opposite condition but is equally as pathologic. Pulpal tissue remains trapped in the remnants of the canal during this process, and although there may be no canal clinically or radiographically, microscopically there is a pathway to a foramen. As a result we can see this clinical condition with radiolucencies periapically. It behooves us to treat these calcified teeth endodontically while the canal is still patent rather than watching its complete closure.

(3) Deep caries, and deep and multiple old restorations in teeth that are candidates for oral rehabilitation, can cause many uneasy moments. Acute clinical judgment must be exercised at this time, for it is often wiser to treat these suspect teeth prior to completing massive restorative dentistry.

(4) There is no question that today, due to our increased facility, knowledge, and skill, more oral rehabilitation of all proportions is being done. These accomplishments have helped many patients retain their own masticatory apparatus for many useful years. We should reflect, however, on several procedures prior to our final insertion of these cases. It may enable us to avoid future embarrassing problems. a) If the most recent radiographs are older than 1 year, a new full series should be taken prior to insertion so that there can be an up to date evaluation of the periapical conditions of all of the abutment teeth. b) All abutment teeth should be pulp tested at that time and non-vital teeth become candidates for endodontic treatment. c) All abutment teeth should be carefully checked for discoloration, indicating a probable intrapulpal hemorrhage and/or resorption. d) Since periodontal problems are frequently the mitigating factor in this rehabilitative procedure, we must be aware of furca involvement and with proper consultation consider root resection. Sectioned roots may be sacrificed or kept and restored depending upon their bone support.

(5) We know that alveolar bone exists in response to the dental apparatus. When a patient is endentulous, the alveolar bone is lost and the wearing of dentures becomes increasingly difficult. In recent years it has been shown that the retention of roots will result in the conservation of alveolar bone. These endodontically treated roots, whether used directly or indirectly in denture retention, will enable a more stable and retentive denture to be fabricated.[4] In the broadest sense, the dicipline of endodontics has helped prevent total masticatory collapse.

(6) Transplantation and replantation must also be mentioned as a method of conserving the patients dentition.

Summary

There is no question that, as we in dentistry start to concentrate more of our efforts in the direction of prevention, we must include preventive endodontics in our thinking. It has been shown that this area encompasses not only the total preventive phase but an interceptive phase which is equally valid in our overall concept of patient comfort and care. It is only when we, as dentists, begin to put together all our varied diagnostic and technical skills, that the patient will receive maximum benefit.

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Journal of PREVENTIVE DENTISTRY

Abstracts of Articles in This Issue of the Journal of Preventive Dentistry
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Gift, H, Milton, B: Comparison of Two National Preventive Dentistry Surveys: 1957 and 1974. J Prev Dent 2 (September-October) 1975.

Abstract: One indication of the change in the philosophies of the dental profession is evidenced by trends in attitudes and practices concerning prevention. The comparison of two surveys, "Factors Associated with Preventive Dental Practices" (National Opinion Research Center, 1957), and "The Role of the Practicing Dentist in the Delivery of Caries Prevention Methods" (ADA Health Foundation, 1974) exemplifies this change. The differences in sample size and characteristics, as well as in questionnaire design, which are discussed in relation to the interpretation of the data, reflect the different outlooks of the two periods. The results also compare differences in the use of preventive measures. The use of radiographs and oral bacteria testing have remained basically the same, while the use of topical fluorides

Kampfe, LV, Wingrove, FA: The Interrelationship of Periodontalendodontal Lesions. J Prev Dent 2: (November-December) 1975.

Abstract: Biologically and clinically, the pathological processes are continuous between the pulp tissue and the periodontal ligament. Lesions and treatment of the pulp will then affect the periodontal ligament and vice versa. The article presents clinical signs and symptoms of this relationship. A Proper diagnosis of the endodonticperiodontic lesion will lead to a sequence of treatment that can restore function to all but the most hopeless teeth.

Spasser, HF: Preventive Endodontics, J Prev Dent 2 (November-December) 1975.

Abstract: Endodontics and its intimate relationship with diagnosis and treatment of pain must be in the forefront of preventive dentistry. This paper will discuss the various aspects of preventive procedures: (1) Total prevention of any injury, trauma or disease process to the tooth; (2) Prevention of injury to the pulp through the judicial use of operative or treatment procedures; (3) Preservation of an already affected pulp; (4) Prevention of unnecessary endodontic therapy by careful differential diagnosis; (5) Preservation of the tooth and root structure through endodontics. Dentists must constantly keep the above factors in mind to maintain patients, through prevention, in a state of ultimate comfort, function, and health.

has greatly increased. The preventive value of attributed to oral prophylaxis treatments has decreased, while the emphasis on the importance of recall has increased. The use of assistants in the office for preventive procedures has increased as has the dentist's participation in school dental health programs. The comparison of these two studies demonstrates: (1) changes of priorities in dentistry from emphasis on water fluoridation to emphasis on comprehensive preventive dentistry; and (2) a stability in the concerns regarding oral hygiene education and improving patient attitudes toward routine and preventive dental care.

Dentistry and the Federal Government

An interview with Assistant Surgeon General John C. Greene, D.M.D., M.P.H.,* by Seymour Shubin.

* Special Assistant for Dental Affairs, Office of the Assistant Secretary of Health, Department of Health, Education and Welfare; Chief Dental Officer, Public Health Service.

Dental coverage under national health insurance, peer review of the quality of dental care, maldistribution of dentists throughout the country, nationwide education and preventive program; these are some of the issues the Federal government is addressing itself to that can affect each and every practitioner. As the top dental health official in HEW and the Public Health Service, Dr. Greene discusses these issues from the position of a man who plays a key hole in formulating and dealing with them; and, equally important to the profession, he discusses them as a deeply-committed colleague. An honored periodontal researcher, epidemiologist, and diplomate of the American Board of Dental Public Health, he has contributed heavily to the literature with dozens of papers and as co-author of the well-known *Oral Hygiene Index*.

INTERVIEWER: I imagine many dentists aren't aware of your function. Since I'm sure that if we went into it in detail it would take up all of the interview, would you describe it at least briefly?

DR. GREENE: Well, in HEW I participate in health policy deliberations from a dental perspective—that is, I provide input to make sure that dental issues are included and, if they are, to see that they are included in the right way. I then provide liaison between departmental activities and outside private and public organizations. An example of the type of questions we deal with is natural health insurance. Should there be dental benefits in it and, if so, how should they be included? Another example is the malpractice issue. Almost all of the publicity has been on physician malpractice insurance, but dentists are affected, too. By virtue of my being a dentist—I was just appointed to the new post of Special Assistant for Dental Affairs this past January—I am able to suggest that dentists' interests be considered along

with those of physicians in designing remedial programs.

My work as Chief Dental Officer in the Public Health Service includes coordinating clinical programs, such as those of Indian Health and the Public Health hospitals and those that provide care for the Coast Guard. The National Institute of Dental Research also comes under the Public Health Service. So does the Division of Dentistry in the Bureau of Health Manpower.

INTERVIEWER: What are some of the main problems the government is working on that will have an impact on dentistry in, say, the next five years?

DR. GREENE: One of them is what to do to relieve the maldistribution of dentists throughout the country. Right now we're working on this largely through student assistance programs. For instance, the government will repay loans made to students who, after graduation practice in areas that DHEW designates as underserved.

Another matter we're trying to deal with is the problem of *quality* of dental service. Up to the present time, the Federal government has focused only on services provided by the medical profession. This has been done through legislation setting up Professional Standards Review Organizations (PSRO) to establish peer review for medical services, such as those provided under Medicaid, which are paid for by the government. Eventually this will also involve dental services, that are paid for by public funds. So, we're trying to develop criteria for peer review and for determining quality of services.

INTERVIEWER: Are dentists concerned about peer review?

DR. GREENE: Yes, many are. One of their concerns is whether there will be Federal interference in the dentist-patient relationship—in fact, I'm sure that's the basic concern. But I think that the intent of Congress in passing the legislation was to enable the profession to do its *own* controlling of quality. As long as we in the dental profession can meet certain criteria concerning quality, then I think peer review will protect the practitioner. Another concern many dentists express is that the system might be so complicated, so weighted down with regulations and paperwork, so time-consuming, that it will make their work less enjoyable and less productive. Well, that's a concern to all of us; we'll be watching that very carefully and will do all we can to avoid it.

INTERVIEWER: Wouldn't you say another of their concerns is that it won't be strictly *peer* review, that laymen will be involved?

DR. GREENE: That's true; but I think that, because of the structure of PSRO's so far, there's more of a concern about whether *physicians* rather than *dentists* will be doing the dental reviewing. But I think the structural problem will be overcome, and we will have true peer review.

INTERVIEWER: What about the prospect of lay review?

DR. GREENE: Well, dentists will review all clinical work, but there certainly will be lay involvement in some of the other matters for instance, to see if the patient's interests, such as confidentiality or patient's right, were considered and taken care of. I think it's appropriate to have non-dentists participate in discussions and debates on these kinds of questions.

INTERVIEWER: What about Health Maintenance Organizations? What is the future of dentistry there?

DR. GREENE: As you may know, the concept of HMOs originated outside of government. For example, Kaiser Permanente in California was one of the first in the field. Later the idea was picked up by the government, and it has been providing funds to help some HMOs get started in the hope that they will become self-supporting. The law mandates that, in order to get federal support, HMOs must offer some dental benefits as well as medical, but these are very minimal. Furthermore, the dental benefits—and, I might add, the mental health benefits also—are in question now. The people who are developing HMOs feel that adding these two benefits is costing them so much that they can't market them very well. Naturally, the more benefits an HMO offers, the higher the cost to the subscriber and the more difficulty the HMO has in getting subscribers. I think, theoretically, that the model of an HMO—where you're trying to maintain health rather than always treating disease—is a very desirable thing. But because of costs involved there is a possibility that the idea

will be modified so that both the dental and mental health benefits will no longer be a requirement for federal support.

INTERVIEWER: Still looking into the future, do you see the concept of group practice growing as compared to individual practice?

DR. GREENE: I do. I think dentists will continue to group together, especially as the overhead costs of private practice become greater. Also, with more specialization, there will be more of an inter-specialty kind of group practice.

INTERVIEWER: Let's talk for a moment about the use of expanded duty auxiliaries. Some dentists have expressed concern that they might take over the basic mechanics of dentistry. Would you comment on that?

DR. GREENE: I don't think there's any justifiable fear about auxiliaries taking over a large part of dentistry. My opinion is that auxiliaries should be used much more than they're likely to be used in the near future. You're right though—one of the concerns many dentists have is if I have a lot of people running around the office doing all the things I used to do, what will be left for me? Well, I think that in the future, general practitioners should be prepared to do many of the things that they now refer to specialists. By delegating many of the routine procedures to auxiliaries, but still retaining responsibility for the quality of what the auxiliary does and everything that goes on in the office, the dentist will have the time to work with more complicated cases himself, and he can really derive more satisfaction from that kind of service.

INTERVIEWER: You spoke of national health insurance before. I know that a number of plans have been proposed—but do all of them include dental benefits?

DR. GREENE: Almost every plan that has come before Congress does include dental benefits to some degree. For instance, the Administration's plan, which was proposed last year, offers comprehensive dental benefits up through the age of 12, with the exception of orthodontia. For health care other than dental, it would be for all ages. Now, Senator Kennedy's bill, as another example, would provide dental care through age 18, I believe, and possibly going on through adulthood. It would be done more through what I would call nationalizing the system.

INTERVIEWER: Don't you think that many dentists will look on both of those bills as leading to socializing dentistry; that, even though the Kennedy bill goes further sooner, the Administration's proposal is still a first step in that direction?

DR. GREENE: I don't think a plan going along the lines the Administration has proposed is in that direction at all—in fact, it is a step *away* from it in that it helps to build on the private practice system and doesn't move it the other way.

INTERVIEWER: Obviously, then, you would prefer the Administration's plan.

DR. GREENE: Yes, I think it's more in the country's interest. Also, the proposal for children's benefits is very similar to what the American Dental Association proposed to the government a few years ago. They went on record as supporting a national children's dental care program in which those who couldn't afford it would have dental care paid for by the government on a sliding scale, depending on how much a person could afford.

I think all of us—myself included, as a government person—are concerned about too much government in our everyday lives, and feel that it's far better to have things moved along by the private sector. When the public interest isn't being handled adequately by the private sector, I think we have to find ways of stimulating it. The plan the Administration is proposing uses a financing mechanism to encourage the private sector to extend its services to more people. The government will be picking up the tab for those people who can't afford it. Otherwise, for most services, the individual pays a part of the cost, the employer pays a part, and the Federal government also has an investment in it.

INTERVIEWER: Let me play the Devil's Advocate for awhile. Approximately what percentage of the people in the country seek professional dental help on a regular basis?

DR. GREENE: It's estimated that it's somewhere around one-fourth of the population.

INTERVIEWER: How important is the cost of dental care as a deterrent?

DR. GREENE: It's a major barrier in dentistry—probably

more so than in any other area of health care.

INTERVIEWER: Well, since it does play a major role, and since the Administration's plan only goes up through the age of 12, that obviously leaves a large part of the population untouched.

DR. GREENE: That's right. Eventually the proposal might cover people up through 18, but I don't think we'll have it for adults in my lifetime except for perhaps some emergency situations.

INTERVIEWER: But if dental insurance only goes up through 12, what do you think the public's reaction will be?

DR. GREENE: I don't think there will be enough of an outcry to make the difference. I don't think the public is that concerned as yet about dental health. I wish we could deal with all age groups—but frankly, though you and I are concerned about people over the age of 12, I am more concerned about something else. I'm more concerned that the cost of total health insurance might be so great that the government might begin to cut *back* some, that is might say, "Well, let's only provide dental coverage through age eight."

INTERVIEWER: Let's say that the Administration's plan goes through. Since the age limit is 12, how can you hope to raise the general level of dental health in this country?

DR. GREENE: One would hope that once children have received good dental care up through age 12, they would be aware of what good care is, and would want to continue to get good maintenance afterwards. Also, if all other health care charges are paid through national health insurance, that will make money available for people to spend on dental care. Another thing which might affect the level of dental health is the recent movement of labor and management in the large industries to include dental care in their contracts. The United Auto Workers have a contract that includes dental benefits for the workers and their families, AT&T has one—in fact, all of the large labor-management negotiations have included dental benefits. And I would expect that movement to continue. Furthermore, I would like to see all of this tied in with a national campaign to educate the public about good dental practices, one that would be a counterpart to the anti-smoking campaign.

INTERVIEWER: Would you anticipate the government playing a large role in this kind of educational program?

DR. GREENE: Yes. But I don't see it being done only by the government. I think, for instance, that the American Dental Association is doing some very interesting and worthwhile things in this regard with their spot films on T.V., and I hope that program will grow. I think the Federal government should offer additives to that. I think, too, that our public school system should be doing much more than it's doing in motivating children to do a better job in taking care of their mouths. Here, also, I think the government can play a big role. I would like to see the funds the government has for public education, such as the Title 1 funds that go to public schools, targeted much more for health education. Also, the Federal government has just established a new Bureau of Health Education at its Center for Disease Control in Atlanta. It has been proposed that, as a part of it, there be a dental health education program that would teach teachers about dental care so that they can be better equipped to pass this along to the children.

INTERVIEWER: Earlier, you mentioned the National Institute of Dental Research. Is the government coming up with any research that looks promising for the near future?

DR. GREENE: Yes, there's research involving oral rinses with fluoride that looks very encouraging in the prevention of plaque and dental caries among children. In fact, the researchers are at the point now of setting up demonstration programs in public schools at ten different sites to determine the beneficial effects and administrative costs of this kind of program. Basically, all it involves is children rinsing out their mouths —I think the regimen will be once a week. If it pays off we may propose it as a national program. Also, if we were to come to an oral rinse program, this is another area that I think the auxiliaries should handle for the dentist. It would be wasteful to have dentists themselves administering that kind of program. I think we might have sort of a "preventodontist"—to put a label on it—working in public schools

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on preventive programs, checking the children and seeing to it that they go to the dentist for the care they need. It has some possibilities. And there may be a possibility—certainly in some underserved areas—of a kind of health aide, like the visiting nurse, going from door to door and talking to families about health in general, including dental health.

INTERVIEWER: Talking about the underserved areas again, is there any way you can think to get more practicing dentists, not just recent graduates, to work in ghettos and rural communities?

DR. GREENE: One possible inducement is an idea that's being discussed but which isn't as yet a part of the Administration's national health insurance proposal. It would set up a variable reimbursement scale, where a physician or dentist would be paid more for an appendectomy or dental procedure that was performed in the ghetto or a rural area than if it were performed elsewhere. But, as I say, this is still under consideration.

INTERVIEWER: I understand that many dental students, even some practitioners, are concerned that, with fluoride programs and so forth, there won't really be anything for them to do one day. What's your feeling about that?

DR. GREENE: There's such a backlog of dental disease I don't see that happening in our time. And even if we're able to control dental caries, there is still so much to be done in the treatment of periodontal problems, orthodontia, oral cancer and so forth. No, I don't see that as a realistic concern. In fact, that brings me to our fluoride programs. Many people have the impression that we've done all that has to be done in terms of fluoridation. It's not so. We have a long way to go. The problem generally lies with the smaller towns and communities that have problems with funding such a program, those which must set up priorities as to whether to buy fluoridation equipment or, let's say, a fire engine.

I'd like to see the Federal government develop a kind of short term, grant-in-aid program to help with the purchase of equipment, perhaps on a matching basis, and also to train someone to operate it. Then the town can take over and supervise operation. This was proposed last year by HEW but was dropped because of costs. However, it will be up again for consideration this year. This is one thing that has to be pushed, and I hope that practitioners in communities where this issue might come up will talk it over with their patients and with others in their communities.

INTERVIEWER: Do you find that dentists in general back fluoridation programs?

DR. GREENE: Yes, but very often they are reluctant to get into the controversy, and I can understand that. The debate can become very bitter in some communities. If a dentist takes a strong stand for it, he ends up gaining some patients and losing others.

INTERVIEWER: As a part of government, as someone who travels a lot, you certainly are in a position to feel how the winds are blowing. In this instance I'm referring to the image that dentists have in the eyes of the general public. What is your impression of that image?

DR. GREENE: I think the image is far better than it was a few years ago, and that it's still on the rise. However, there are a few things which appear in the newspapers that give us a setback, such as dentists taking advantage of some public program. For instance, the Medicaid program. Recently there have been newspaper articles about a few dentists who charged huge amounts to the Medicaid program in one year's time. That catches the public's eye, and people think that all dentists are out to get as much as they can, which is far from the truth. But even a few dentists, taking advantage of a program, really hurt us. Fortunately they're in the minority, and I hope with our quality assessment utilization review programs, some of them will be weeded out. The more the profession does to correct the problems, the better its public image will be.

INTERVIEWER: I want to go back to the future again—which certainly sounds like a contradiction in terms. But what I'm referring to has to do with dental schools and, indirectly, dental faculty and future dentists. Where does the government stand now in giving financial support to the schools?

DR. GREENE: As you probably know, over the last ten years there has been a large increase in the number of den-

tal schools largely because of Federal funding. More recently, there has been increased Federal funding for the schools' operating support, called capitation.

The enabling legislation expired last June and there has been a great debate in Washington about what the succeeding legislation should be, whether or not we should continue with the capitation funding or phase it out. The Administration would like to decrease the amount of money that goes to the school in the form of capitation, and the Office of Management and Budget would like to see it phased out eventually. The Congress, on the other hand, is more inclined to keep it at about the same level as now, but to attach some other strings to it that the schools be required either to increase enrollment or to do some other good things such as train students in outlying areas away from the school or train more auxiliaries so that you can increase the productive capacity of those dentists who do graduate. As for the Administration, though it proposes lowering the capitation, it also proposes increasing the amount of scholarship funds that would go to the students which would help to offset some of the expected increase in tuition if capitation is decreased.

In other words, if the government doesn't contribute as much capitation, it will drive tuitions up. If that happens, what will it do to the mix of students? Will it price dental and medical education out of the market? Are we only going to have students from well-to-do families? Is dentistry to become even more of an elitist profession? We don't know. We also don't know what the long term impact of the cost of education is going to have on the cost of dental care.

INTERVIEWER: You mean the consumer will have to make it up.

DR. GREENE: Somebody's going to have to pay for it. It not, the practitioner of the future can get caught in a bind. If it costs you $40,000 to get a dental education, and another $40,000 to open an office, one of the things you want to do is get out of debt, make that money back. But the public, already concerned about the cost of care, may put on cost controls. The practitioner of the future could be caught in a real squeeze between his debts and the limitations on what he can charge. And dentistry may not be as attractive a profession in the future. We will have to come up with some sort of solution.

INTERVIEWER: We've covered quite a bit of ground in this relatively short period, and I want to thank you for your cooperation. But there's just one more thing I want to cover. We've talked about a number of things affecting dentists, such as national health insurance, that would seem to require some political activity on their part. What can the individual do to be politically active?

DR. GREENE: He certainly has to keep advised on what's happening in Washington, what bills are coming up—in other words, keep abreast of the news, read the professional journals. Then he should be involved in his local and state dental societies. I would guess that every state society, at least, has a political action committee. He should take positions on national issues which can be passed on to the national societies. Actually, dentists are already more politically active than they used to be. And I hope they will be much more active tomorrow than they are today.

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Comparison of Two National Preventive Dentistry Surveys:*

1957 and 1974

Helen C. Gift, Ph.D.** and B. Bayley Milton, B.A.**

One indication of the change in the philosophies of the dental profession is evidenced by trends in attitudes and practices associated with prevention. The comparison of two national surveys, "Factors Associated with Preventive Dental Practice," conducted in 1957 by the National Opinion Research Center,[4] and "The Role of the Practicing Dentist in the Delivery of Caries Prevention," a 1974 project by the American Dental Association,[2] exemplifies this change.

Since 1957, many aspects of preventive dentistry have been expanded, developed, and applied. The value of certain contemporary preventive procedures has been clearly established, and the delivery of such services, especially to children, is now greatly influencing the practice of dentistry. The purpose of this article is to consider these changes.

METHODOLOGY

The 1957 nationwide survey of dentists regarding preventive services, conducted by the National Opinion Research Center (NORC, 1959) was done not only during a period of concerted effort to fluoridate water supplies artificially, but also at a time when the employment of hygienists for the delivery of certain preventive procedures had not been systematically studied.

The 1957 NORC survey involved interviews with 750 dentists who represented 1 per cent of all dentists in the United States actively engaged in the private practice of dentistry. Excluded from the sample were dentists not listed in the ADA directory, those engaged in teaching, research, or administration, or those dentists practicing primarily in institutional settings.

As suggested by the American College of Dentists, the preventive measures studied were: (1) recall systems; (2) oral prophylaxis treatments; (3) tooth-brushing instructions; (4) periodic radiographic surveys; (5) dietary control recommendations; (6) restoration of primary teeth; (7) topical fluoride applications; (8) oral hygiene education; (9) biopsies of abnormal soft tissues; (10) treatment of fractured incisors; (11) appearance of gingival tissues; (12) laboratory tests for determination of caries activity; (13) promotion of water fluoridation; (14) participation in or consultation with community health groups; and (15) cooperation with dental health education programs. The interviews primarily involved questions concerning the dentists' attitudes toward and actual use of these procedures and activities.

The 1974 survey was based on a systematic national sample of all practicing dentists listed in the ADA registry of dentists, resulting in a 5 per cent sample, or 4,000 mailed questionnaires. Specifically excluded from the sample were federal and state dentists, full-time dental school faculty, retired dentists, administrators, interns, residents, and dentists over 65 years of age. The 1974 study determined use of a more limited set of preventive procedures: (1) fluoride dentifrices; (2) nutrition and diet counseling; (3) oral health education for home care; (4) pit and fissure sealants; (5) professional prophylaxis; (6) recall systems; and (7) topical fluorides; and included attitudinal questions directed toward the provision of com-

* This is a revision of a paper presented at the 53rd General Session of the International Association of Dental Research, 1975. This investigation was supported by Contract No. 1-DE-32423 from the National Institute of Dental Research.

** American Dental Association, 211 E. Chicago, Chicago, Illinois, 60611.

Table 1. Use of Laboratory Tests and Use of Radiographs

	1957	1974
Use of Radiographs	99% ± 0.8%*	98.6% ± 0.4%
Use of Laboratory Tests	22% ± 3.0%	20.9% ± 1.4%
N	758	3225

* 95 per cent confidence level.

prehensive preventive dental care to the nation's children, exclusive of water fluoridation.

COMPARISON OF TWO SURVEYS

A. Use of Procedures

In the 1957 study, topical fluorides and laboratory tests were the two preventive measures used least frequently and least routinely. Despite the fact that a majority of those dentists who used a recall system felt that it benefited the patients by making routine preventive dental care possible, less than a majority consistently employed recall systems. Dentists in this study were most inclined to give as reasons for *not* using the above procedures their belief that such measures were ineffective and unnecessary. Oral hygiene education was the procedure thought to be most effective and was used by almost all of the dentists (99%).

The intervening years have seen a remarkable change in dentists' attitudes toward the above measures. While the use of laboratory tests and radiographs has not significantly changed (Table 1), the results of the present study show that recall systems and topical fluorides are now not only thought to be of value in aiding the prevention of caries, but also are widely and routinely used by a majority of the dentists (Table 2). When measured by value attributed to the procedures, emphasis on prophylaxis treatments and oral hygiene education, as preventive procedures, has decreased (Table 3).

As discussed in "The Use of Scales in Interpreting Survey Data: Preventive Dentistry"[3] based on the 1974 survey, scales of dentists' preventive utilization and attentiveness were developed which approximate the scales established in 1957. Very similar results have been found in the analysis of these scales, indicating the reliability of the scaling technique. In both studies, the most preventive dentists tend to be young, be more attentive to professional activities outside the office, work with auxiliaries, treat more children under 6 years of age, earn a higher income from the practice of dentistry, and place more value on preventive dental procedures. Thus, while the proportion of dentists who use various preventive procedures may have increased, and the types of preventive procedures used may have changed somewhat, the characteristics presently associated with being a preventively-oriented dentist are similar to those of 17 years ago.

Table 2. Use of Recall and Use and Value of Topical Fluorides

	1957	1974
Use of Recall	76% ± 3.0%*	93% ± 0.9%
Value of Topical Fluorides	24% ± 3.0%	46% ± 1.7%
Use of Topical Fluorides	57% ± 3.6%	92% ± 0.9%
N	758	3225

* 95 per cent confidence level.

B. Attitudes Toward Auxiliary Personnel

Attitudes toward the use of ancillary personnel have also changed over the years. In 1957 only 7.5 per cent of the dentists employed hygienists; in 1974, 24 per cent report employing full-time hygienists. In many practices, hygienists are now frequently delegated the responsibility of performing topical fluoride applications, de-

Table 3. Value Attributed to and Use of Prophylaxis and Oral Hygiene Education

	1957	1974
Great value to Oral Hygiene Education	85% ± 2.6%*	71% ± 2.6%
Provide Oral Hygiene Education	99% ± 0.8%	96% ± 0.7%
Great value to Prophylaxis	88% ± 2.4%	38% ± 1.7%
Use of Prophylaxis	96% ± 1.4%	96% ± 0.7%
N	758	3225

* 95 per cent confidence level.

Table 4. Proportion of Dentists Using Personal Oral Hygiene Education

	Staff Performing				
	Dentist	Hygienist	Assistant	Combination	N
With Hygienists	7.4% ± 1.5%**	49.3% ± 2.8%	8.1% ± 1.5%	35.3% ± 2.6%	(1236)
Without Hygienists	61.3 ± 2.4%	*	19.9 ± 2.0%	18.4 ± 2.0%	(1508)
With Assistants	33.7 ± 2.2%	23.5 ± 1.6%	15.5 ± 1.4%	27.3 ± 1.7%	(2580)
With Assistants But No Hygienists	57.5 ± 2.5%	*	22.1 ± 2.2%	20.1 ± 4.2%	(1354)
Without Assistants	89.6 ± 5.0%	*	*	*	(164)

* Cell size under 10.
** 95 per cent confidence level.

livering oral hygiene education, and counseling on diet and nutrition.

Changes in the use of assistants are not as evident.[1,4,5] While the use of assistants for preventive procedures has increased, dentists still tend to be uncertain about entrusting major responsibilities to dental assistants, and frequently indicate that, in the absence of a hygienist, a combination of staff is often used for preventive procedures (Table 4 illustrates this for oral hygiene education).

C. Participation in Community Health Activities

The 1957 survey indicated that only 15 per cent of all dentists belonged to or worked with any community health groups other than those associated with schools. The 1974 survey results indicate that approximately 37 per cent of the dentists participate in some local health activity outside their private practice. Thus, dentists have become more actively involved in community health programs, possibly due to more opportunities for participation and a growing awareness of their responsibilities as health educators.

D. General Characteristics

Dentists' incomes have increased, their practices are more structured, the employment of auxiliaries is more frequent, and dentists are more often able to participate in activities outside of the private practice. All of these are expected trends, however, that are associated with changes in the economy and increased opportunities for the delivery of health care and education to the public for preventive purposes.

SUMMARY

While in the 1950's major emphasis was placed on water fluoridation, the comparison of these two studies illustrates how dentistry has devised alternate solutions to the problems of caries prevention. The change in patterns of use of specific procedures, such as topical fluoride treatments, reflects the dentist's adjustment to advances in scientific knowledge. Also, the experimentation with different approaches to prevention reflects the dentist's awareness that several approaches to prevention may be needed to reach the greatest possible number of people.

The comparison between these two studies also illustrates a stability in the dental profession's concerns regarding the oral hygiene of patients and the use of all possible means to improve patient attitudes toward routine and preventive dental care.

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